Maedi-visna impact on productivity in Quebec sheep flocks (Canada)

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Summary
The impact of maedi-visna seropositivity on productivity was evaluated in commercial sheep flocks of the province of Quebec, Canada. A total of 1734 ewes were selected randomly from 29 flocks. Serostatus was determined with an ELISA test using recombinant proteins. Seropositivity in ewes was not associated with litter size or lamb's birth weight. A decrease of 0.94 kg per lamb in weaning weight was seen for lambs born and raised by seropositive ewes ≥ 4 years old, and seropositivity in ewes of any age was associated with an increase in 0-30 days lamb mortality (OR:1.65).

Introduction
Maedi-visna (MV) is a life-long chronic infection of sheep caused by a lentivirus. Infection by the maedi-visna virus is frequent in North America5. In a previous study in Quebec, an ELISA test reported that 40% of tested sheep and 81% of tested flocks were seropositives9.

The virus affects mainly lungs and mammary-gland tissues by lymphocytic inflammation. Clinical signs may appear after a long incubation period (≥ 3 years), and are mostly characterized by chronic weight loss and exercise intolerance, leading to respiratory distress and death. In North America, the importance of the infection has been mostly attributed to a decrease in productivity caused by subclinical lesions5. In the United States, Keen (1994) found that seronegative ewes produced at weaning 4.95 kg more lamb weight per ewe ram-exposed compared to their seropositive flockmates. This was attributed to the cumulative effect of infection on ewe fertility, lamb's birth weight and daily weight gain5. Other studies conducted in Canada, United States, Italy and South Africa reported a less important or no impact of ewe seropositivity on productivity2,3,6,10.

Objectives
This study was conducted to estimate the impact of the MV infection on farm productivity in Quebec sheep flocks. In Quebec, sheep are mainly raised for meat. Consequently, the productivity measures were litter size, lamb birth weight, lamb weaning weight and pre-weaning mortality.

Material and methods
This study was conducted in the province of Quebec, Canada. Sample size was fixed at 10 flocks in the region of Estrie and 20 in the region of Bas-St-Laurent, which was proportional to the size of the sheep population in these areas. Only commercial flocks with ≥ 60 ewes assumed to be in the last 2 months of gestation in December 1999 were eligible to the study. Enrolment was done on a voluntary basis.
For each flock, 60±2 ewes in late gestation were selected. Selection was done using a stratified systematic random sampling method for breed, age category (1, 2-3 and ≥ 4 years) and pens. At selection time, body score was evaluated by palpation of the lumbar region. Age was established by incisor examination. Standardised record forms for lambing, weaning, and mortality were provided and explained to the producers. Producers were also asked if they had ever tried to control MV infection in their flock, and the methods used. Flocks were visited every 3 weeks from the beginning of the lambing to the end of the weaning period to validate records form and to calibrate scales used by the producers to weight lambs.

At time of selection, a blood sample was collected from all selected sheep using jugular venipuncture. Serum was frozen at -20°C or -70°C for a maximum of 4 months prior to analysis. An ELISA test using recombinant proteins was used to detect MV antibodies.

In general, mixed-models including random intercept and fixed effects were used. Models were fitted using 2nd order PQL estimation (binomial outcome) or the RGILS algorithm (continuous outcome) in MLwiN. For binomial-outcome models, the logit link function was used. Control variables and interactions were chosen based on prior knowledge of biology and potential confounding with MV serostatus. Only models respecting assumptions of normality, linearity and homogeneity of variance were considered.

For the litter size model, only 8% of ewes lambing had ≥ 3 lambs. Thus, ewes having ≥ 2 lambs were grouped and the litter size was analyzed as a binomial outcome (1 vs ≥ 2 lambs) in a two-level (flock, ewe) model. For the lamb birth- and weaning-weight models, three-level models were built. Adopted lambs were excluded from the weaning-weight model. The lamb mortality model was restricted to the 0-30 days period, and one lamb per litter was randomly selected for statistical reasons to built a two-level model (flock, lamb).

Results

In one out of the 30 selected flocks, a test-and-cull program for MV has been implemented before the beginning of the study. This flock was excluded from any further analysis. A total of 1734 ewes were sampled from the 29 remaining flocks. The overall seroprevalence of MV was 32% (628/1954). Flock seroprevalence varied from 3% to 70%.

Selected ewes gave birth to a total of 2588 lambs; 2117 of them were followed until weaning, 356 died before weaning and 115 were lost during follow-up.

Ewe MV serostatus was not associated with litter size (P=0.69) or lamb’s birth weight (P=0.76) in models adjusted for age and body score. Alternative models were built without body score as covariate because of a possible impact of MV infection only through wasting; these models led to the same conclusion.

In the weaning-weight model (adjusted for flock, litter size, ewe body score, mortality in the litter, lamb gender, birth weight and weaning age), an interaction (P=0.03) was present between MV serostatus and the age of ewes. Thus, sub-models per age category were run. Only lambs born from older seropositive ewes had reduced weaning weights (P=0.48 for 1 year old ewes; P=0.19 for 2-3 years old ewes). The weaning-weight of lambs born from seropositive ewes ≥ 4 years old was reduced by 0.94 kg (P=0.02).
Maedi-visna serostatus was associated with the 0- to 30-day lamb mortality (OR : 1.65; \( P = 0.03 \)) in a model including ewe age and body score, litter size, lamb gender, and lamb birth weight. The estimated lamb mortality percentage was 4.7% for seronegative ewes compared to 7.5% for seropositive ewes; these percentages were calculated for 2-3 years old ewes, ewe’s body score \( \geq 2.5 \), a litter size of two lambs, a female lamb and a lamb birth-weight of 4 to 4.9 kg. Alternative models were built for younger lambs, but MV seropositivity was non-significant in those models (0-2 days: \( P = 0.19 \); 0-10 days: \( P = 0.11 \)).

**Discussion**

A reduction of lamb weaning weight was associated with ewe seropositivity, probably caused by a decreased milk production secondary to MV mammary-gland lesions\(^7\). The decrease in weaning weight was detected only for the ewes \( \geq 4 \) years old. It is biologically probable that this age group was the most-severely affected by MV because of the long incubation period of the disease. The magnitude of this reduction is higher than the result of a study (0.59 kg) comparable to ours relative to mean age of lambs at weaning and adjustment for confounders\(^5\). However, in the latter study, this reduction was an average for ewes of any age. Another similar study, conducted in Canada, did not find any association between lambs weight and ewe MV-serostatus\(^8\); however, serostatus was determined either by complement fixation or agar gel immunodiffusion, two serological tests having a poorer sensitivity compared to ELISA\(^1\).

The serostatus of ewes was associated with the 0-30 day lamb mortality. In another study, mortality of lambs was associated with MV mammary-gland lesions, which was believed to cause a lack of milk\(^7\). However, other studies did not find association\(^4,5,10\).

Many reasons could justify the eradication of MV from a flock or an area, including losses in productivity. A cost-benefit analysis considering losses in productivity and other potential impacts is recommended before the establishment of MV eradication program as well as the optimal way to achieve it at a flock or a regional level.

**References**