Identification of *Salmonella* risk farms by serological surveillance at preharvest level: Mission Impossible!?

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Introduction

The EU Zoonoses Regulation Nr 2160/2003 requires Member States to take effective measures to detect and control *Salmonella spp* of public health signicance.The Belgian Federal Agency for the Safety of the Food Chain (FASFC) installed a National ***Salmonella* surveillance and control program in pigs (SAP)** in January 2005 which became compulsory in July 2007. The surveillance is mainly based on serological screening (ELISA) at preharvest level. By targetting those farms with a persistently high sero prevalence at farm level, it is intended that the national prevalence of pigs infected with *Salmonella,* and ultimately the number of human cases of *Salmonella* attributable to pig meat consumption, will be reduced over time. In a first stage, the aim of the FASFC is to assign maximum 10% of the herds as *Salmonella* risk herds.

Objectives

Obtain insight in the serological data obtained within the SAP in order to assign herds as risk herds based on ELISA results (SP ratio).
Which (influential) factors should be taken into account in order to classify farms as *Salmonella* risk herds ?
Study within- and between herd variability in serological results.

Material and Methods

- Study population: pigs from all production holdings in Belgium (= weaners, growing pigs and finishing pigs)
- Sampling: A two-stage sampling: 10 to 12 blood samples (~herd size) of different weight categories (<40 kg, 40-59kg, 60-79 kg and ≥ 80kg) were collected in each pig herd every 4 months
- Samples/herds:± 200 000 serum samples/year from ± 7800 pig farms
- Test: *Salmonella*-specific antibody ELISA (Idexx Laboratories, HerdChek - Swine *Salmonella* Antibody Test Kit).
- Response variable: SP ratio
- Influential factors: Season effect (time effect) – pig weight effects – Spatial effects – within and between herd variability
  - ✓ Within-herd-prevalence: Logistic regression (SAS)
  - ✓ Linear mixed models to capture the herd effect, season and pig weight: $\text{SP\_ratio\_transformed} = \beta_0 + \alpha_1 + \beta_1\,\text{days1\_std} + \beta_2\,\text{days2\_std} + \beta_3\,\text{days3\_std} + \beta_4\,\text{category\_pig weight} + \varepsilon ij$

with $\beta_0\ \beta_1\ \beta_2\ \beta_3,\ \beta_4$ the population level parameters of interest and α_1 was the random intercept of the specific herd i. The models were build on the assumption of normality with respect to the error term εij and the random intercept α1. The SP ratio's were transformed into SP-ratio_transformed. The variable days was standardised (days1_std) to avoid computational problems. Also quadratic (days2_std) and cubic terms (days3_std) were standardised to avoid multicollinearity and possible computational burden.

Results

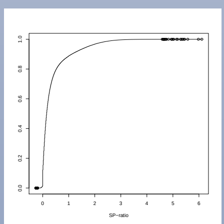

Figure 1

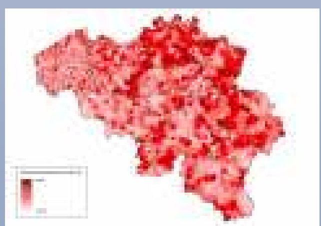

Figure 2

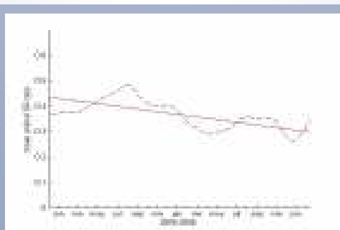

Figure 3

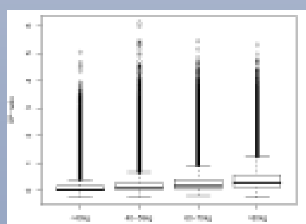

Figure 4

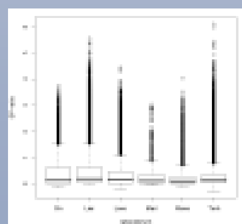

Figure 5

- ➢ **Figure 1:** Cumulative distribution of SP ratio's from more than 600 000 samples obtained within SAP. About 90 % of the samples have a SP ratio ≤ 1.00 (=40%OD)
- ➢ **Figure 2**: Spatial differences between provinces in Belgium. Distribution of within-herd sero prevalence in Belgium according a cut off value of 0.25 SP ratio. Highest mean SP ratio were found in the provinces of Antwerpen and Limburg (north and east of Belgium) while lowest mean SP ratio's were found in in West-Vlaanderen (west of Belgium).
- ➢ **Figure 3**: Significant seasonal effects were observed with higher SP ratio's when sampling occurred during summer and autumn compared to the winter months. A declining trend in the mean sp ratio is obvious from 2005 onwards.
- ➢ **Figure 4**: Pig weight effects. The mean SP ratio's from finisher and slaughter pigs (=80 kg) are significantly higher compared with those of weaned piglets below 40 kg.
- ➢ **Figure 5**: Lab differences. Significant differences were found between de SP ratio's from samples tested in different laboratories in Belgium.

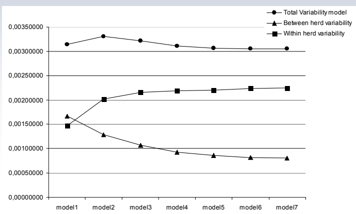

Figure 6:

➢ **Figure 6**: Within and between herd variability: How many sampling rounds should be taken into account ?

❖Seven different models were used to fit data obtained form 7,702 herds sampled 7 times since January 2005. The first model was fitted by using data obtained from the first sampling round. The second, third, fourth, fifth, sixth and seventh model were fitted by the first 2, 3, 4, 5, 6 and 7 sampling rounds correspondingly. The models clearly show that the variability between the herds becomes smaller and smaller when more data were used to fit the model. Stability was achieved after 3 successive sampling rounds. In contrast, the within-herd variability increased across the 7 models.

❖ the mean squared predicted error and its variance in the succeeding models changed very slightly after three successive sampling rounds.

Conclusions & Discussion:

Since July 2007, *Salmonella* risk farms are classified as farms with a mean SP ratio equal or higher than 0.6 for 3 successive sampling rounds. Until now (March 2008) more than 60% of the selected risk herds had at least 1 positive faeces. However, identification of *Salmonella* risk farms is a (very) difficult task as many (un)known factors should be considered (such as sampling plan) to install a *Salmonella* surveillance program at preharvest level.