The economic value of biomarkers in milk
Case-study analysis of fat/protein ratio (FPR) and fatty acid profile (FAP) for early detection of subacute ruminal acidosis

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Introduction

In the last few years biomarkers in milk have gained attention to detect subacute ruminal acidosis (SARA). The value of such biomarkers depends on the degree to which they enable better management decisions.

Objectives

- To estimate the value of biomarkers to inform treatment decisions regarding SARA, compared to no monitoring
- To investigate the factors influencing the value of biomarkers as monitoring strategy

Method

Using input data for treatment cost, disease cost, prevalence and test characteristics, a stochastic decision tree simulation model was applied on a typical Belgian 2013 dairy farm with herd size 95 and net cash farm income per cow €1,750 (IFCN, 2014).
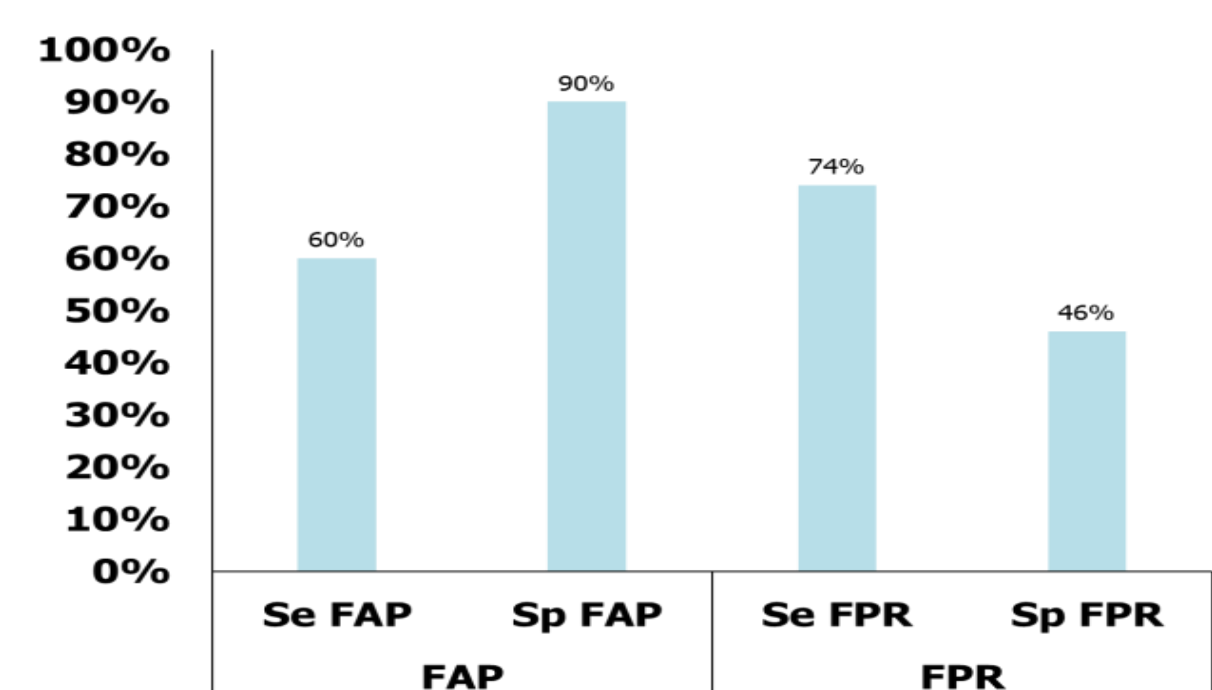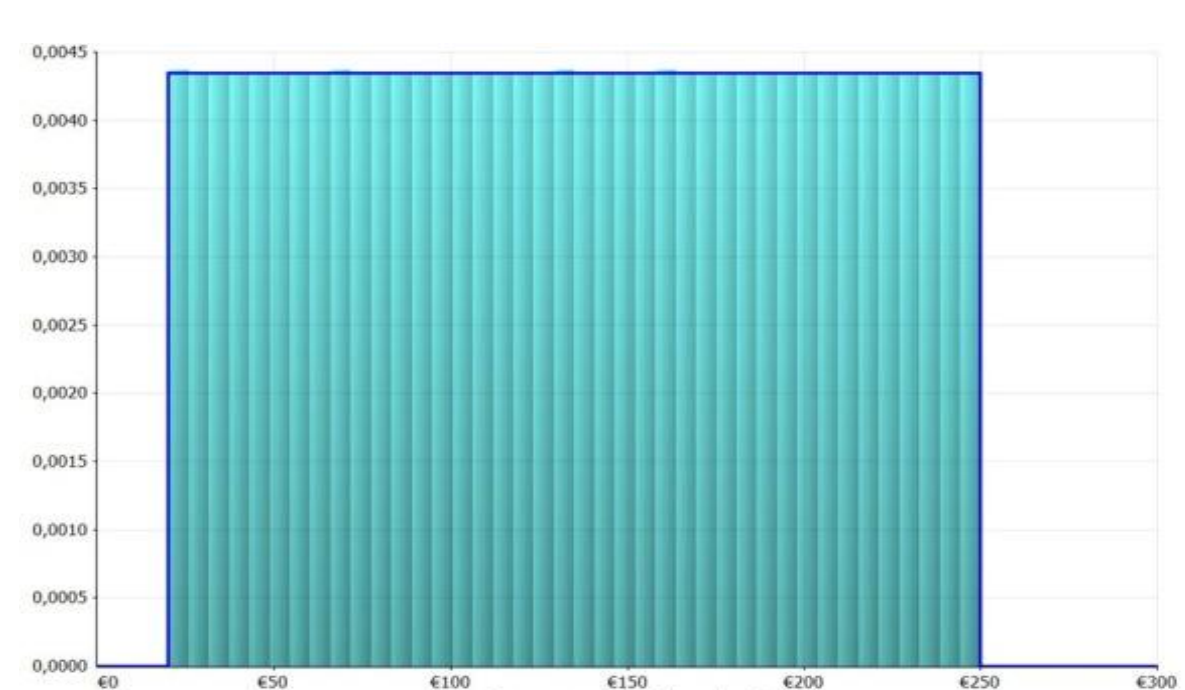

Test characteristics (SE and SP). Data from 4 experiments from Colman et al. (2012; 2013; 2015)
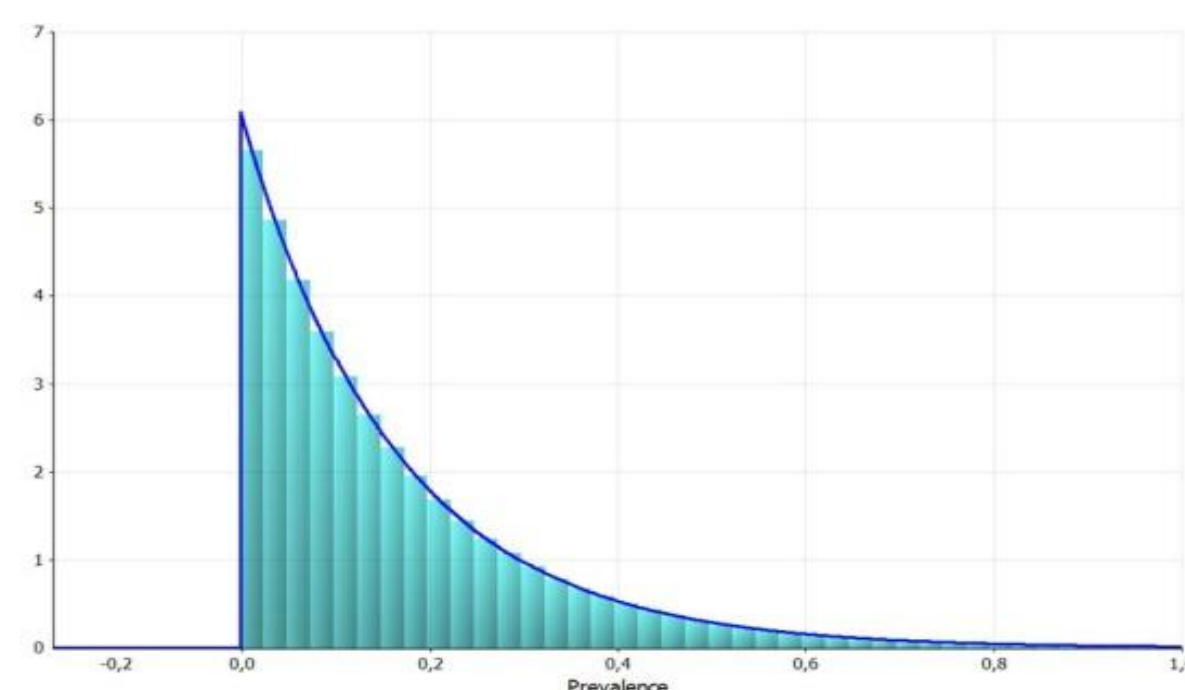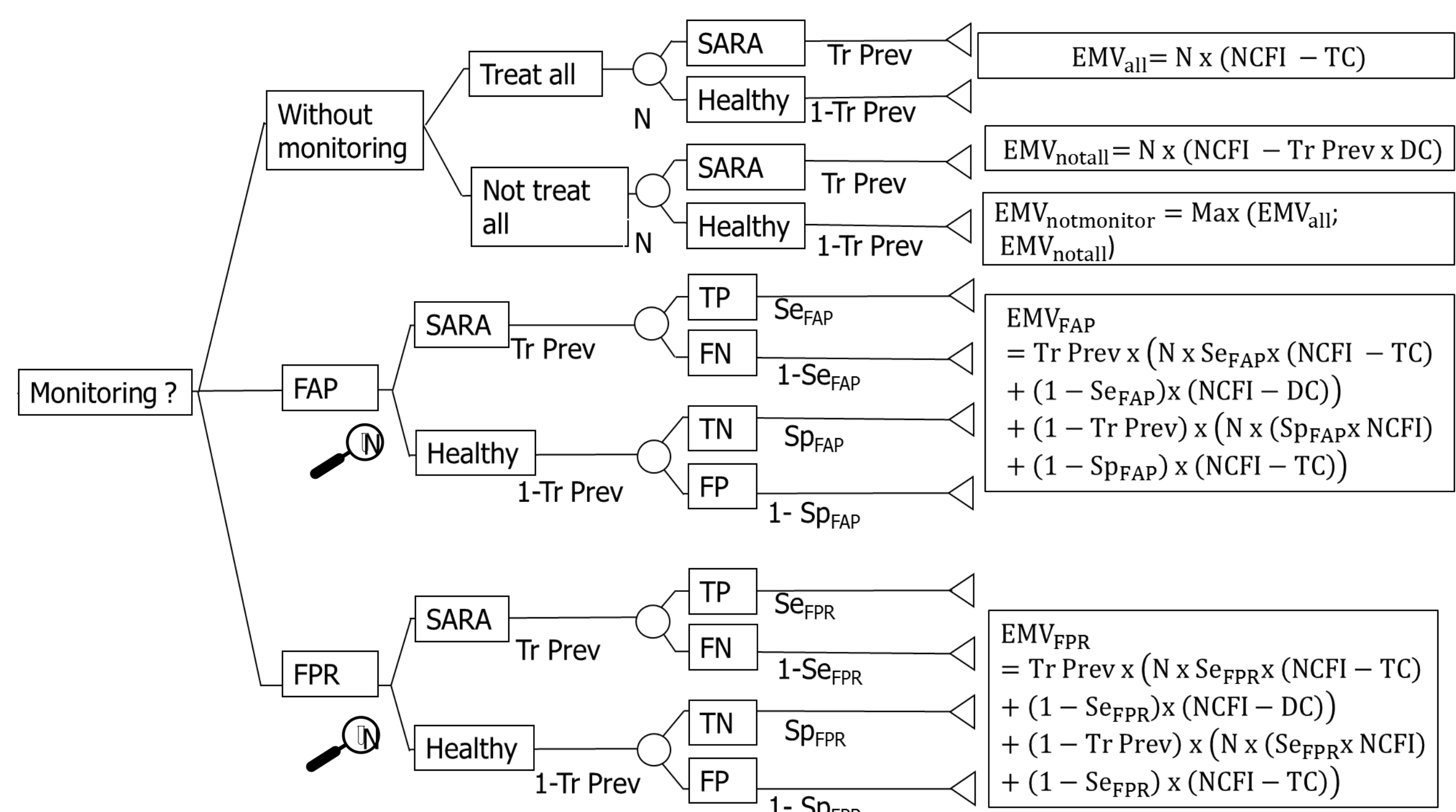

Prevalence (Prev.,%). Fitted function based on O'Grady et al., 2008; Kleen et al., 2009, 2013; Tajik et al., 2009; Kitkas et al., 2013
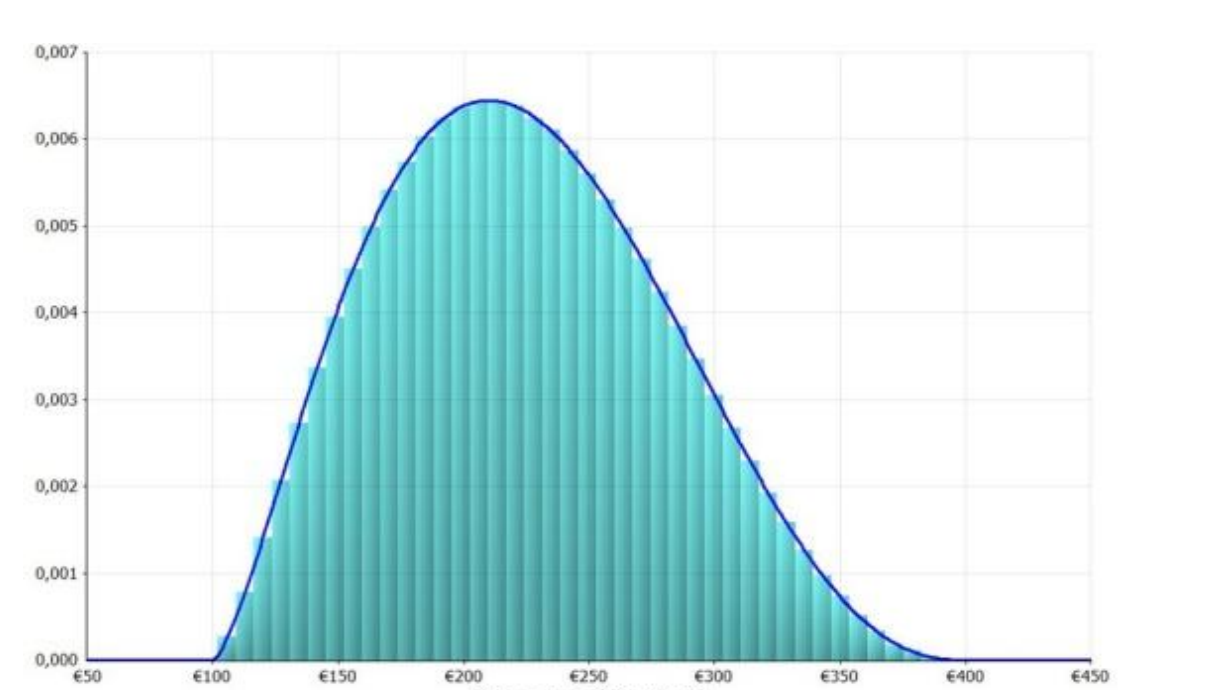
Disease cost (DC, €/cow/y). Stone (1999) and triangulation by expert knowledge
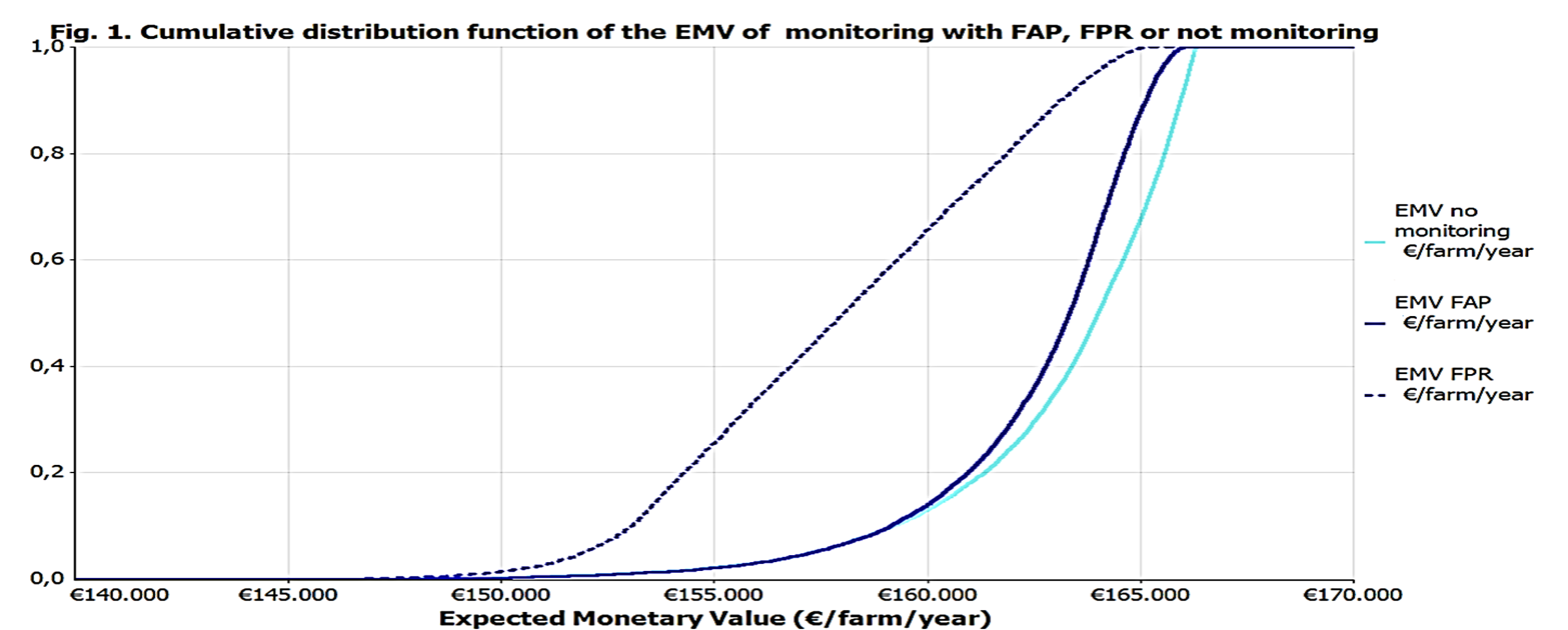

Treatment costs (TC, €/cow/y). (Huitjens, 1991; Kampf and Segers, 2015)

$$EMV_{all} = N \times (NCFI - TC)$$

$$EMV_{notall} = N \times (NCFI - Tr\ Prev \times DC)$$

$$EMV_{notmonitor} = Max\ (EMV_{all}; EMV_{notall})$$

$$EMV_{FAP} = Tr\ Prev \times (N \times Se_{FAP} \times (NCFI - TC) + (1 - Se_{FAP}) \times (NCFI - DC)) + (1 - Tr\ Prev) \times (N \times (Sp_{FAP} \times NCFI) + (1 - Sp_{FAP}) \times (NCFI - TC))$$

$$EMV_{FPR} = Tr\ Prev \times (N \times Se_{FPR} \times (NCFI - TC) + (1 - Se_{FPR}) \times (NCFI - DC)) + (1 - Tr\ Prev) \times (N \times (Sp_{FPR} \times NCFI) + (1 - Se_{FPR}) \times (NCFI - TC))$$

Results

Fig. 1. Cumulative distribution function of the EMV of monitoring with FAP, FPR or not monitoring

The strategy to base decisions on no monitoring mostly dominates the strategy to base decisions on biomarkers. This is mainly a consequence of the low prevalence: at a most likely prevalence of 16% and given treatment and disease costs, there is no value from biomarkers. When using biomarkers, FAP is always better than FPR, in spite of reduced sensitivity but thanks to better specificity.

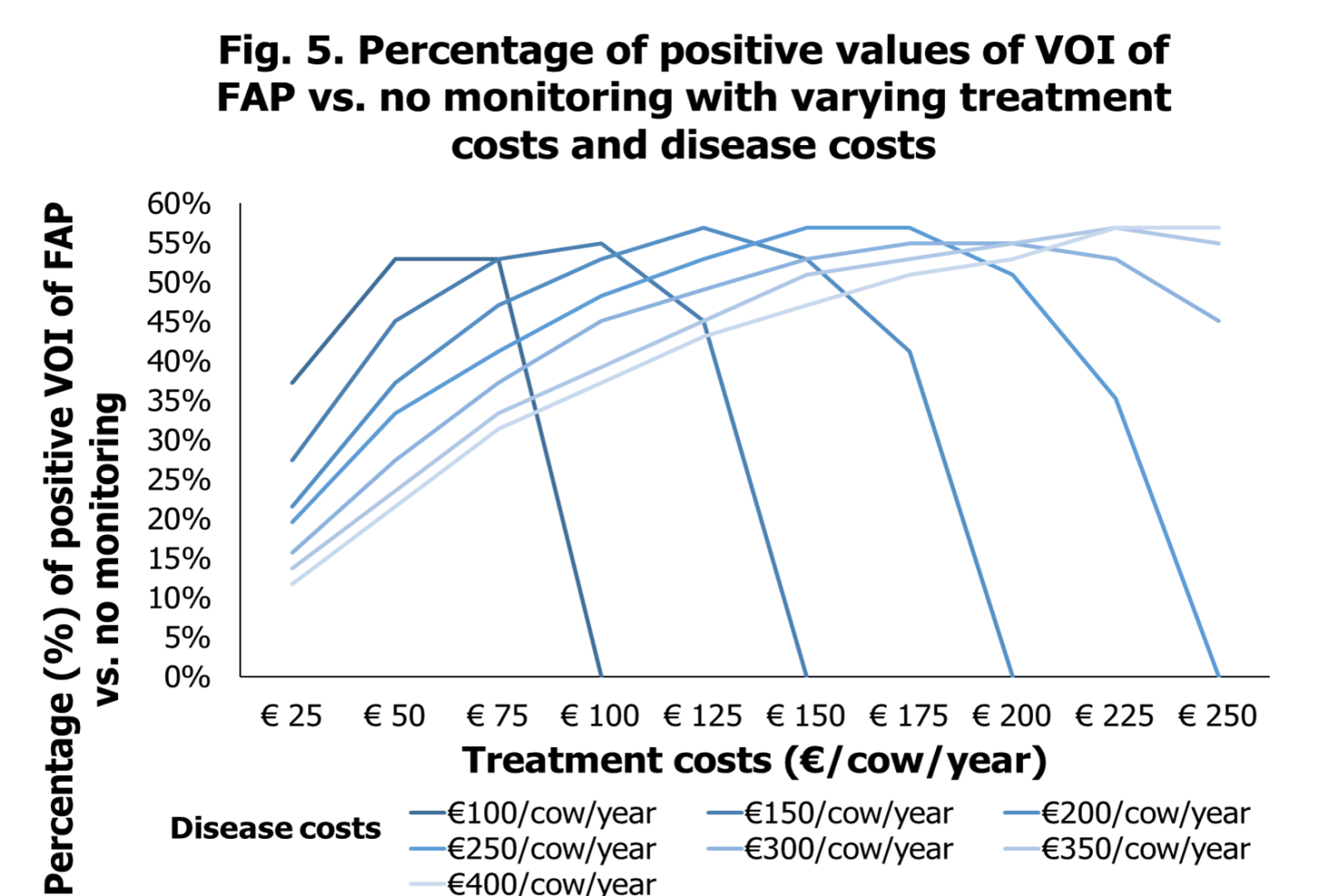Fig. 2. Surface graph of the effect of herd size and Prevalence (%) on the VOI of FAP vs. no monitoring
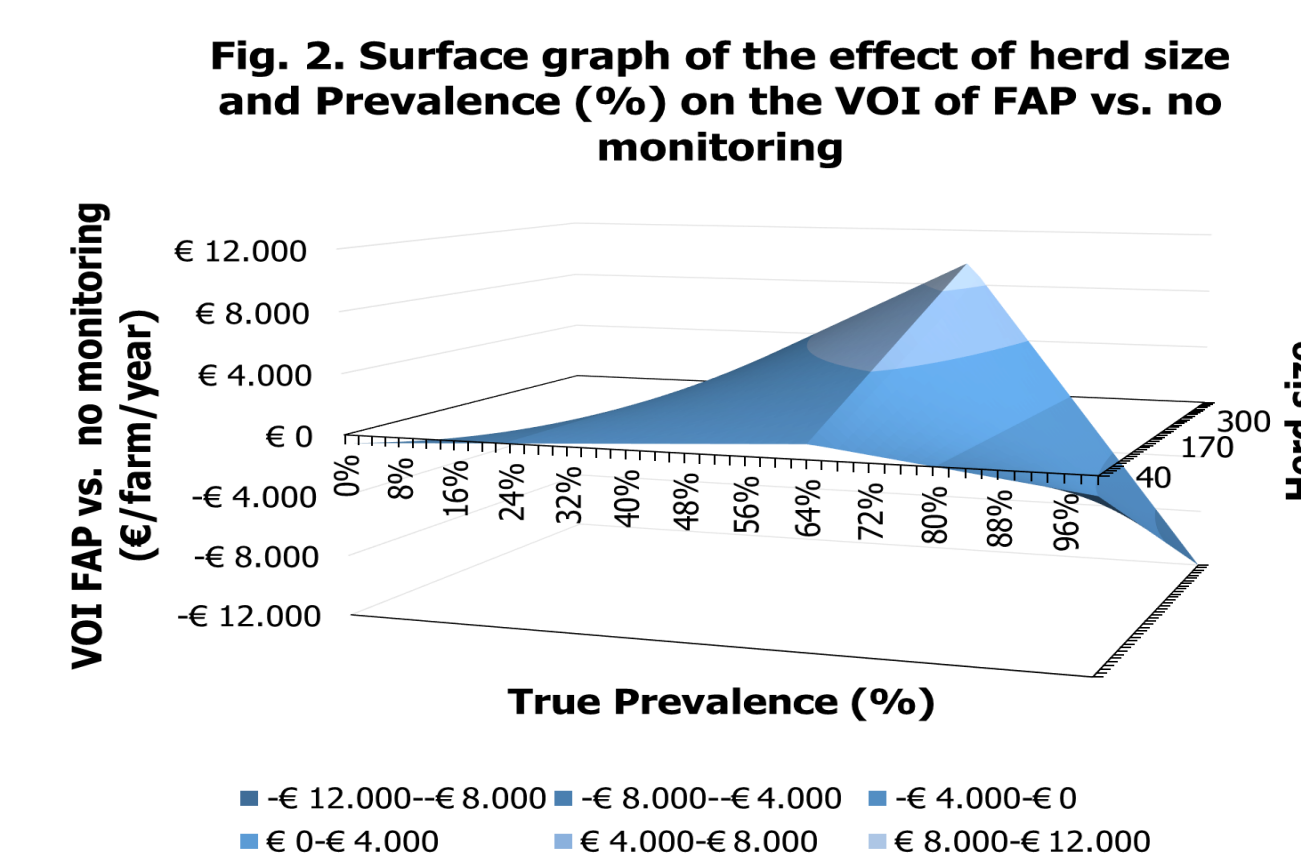
At average treatment (135€/cow/y) and most likely disease cost (210€/cow/y), using FAP biomarkers has a positive value for a prevalence between 24% and 80% and increases with herd size. Outside this range, the value of FAP is negative.

Fig. 3. Scatter plot and trend line of the effect of disease costs on the VOI FAP vs. no monitoring
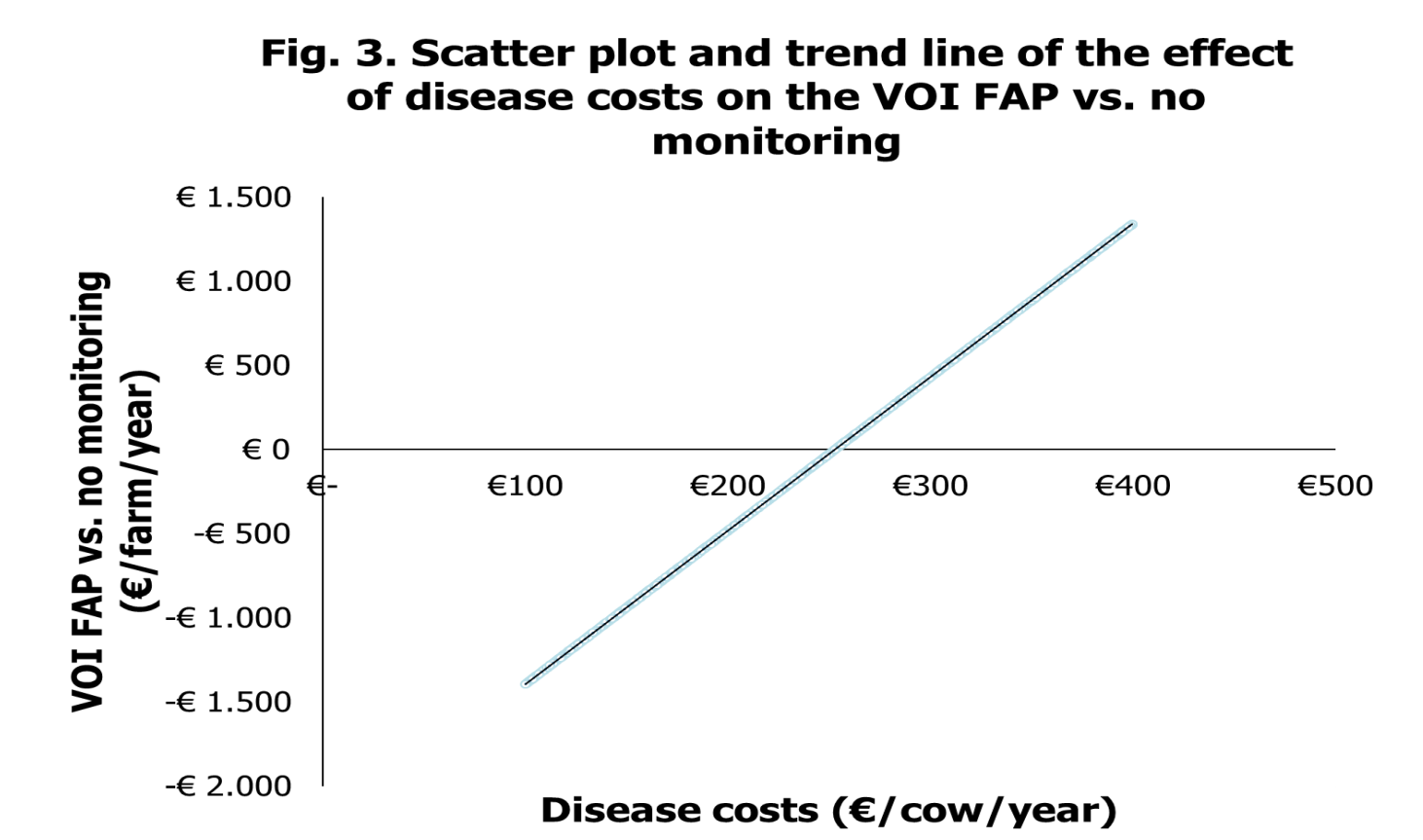
At average treatment cost (135 €/cow/y) and most likely prevalence (16%), the value of FAP increases with disease cost and becomes positive at a disease cost of 250€/cow/y

Fig. 4. Scatterplot of the effect of treatment costs on the VOI of FAP vs. no monitoring (€/farm/year)
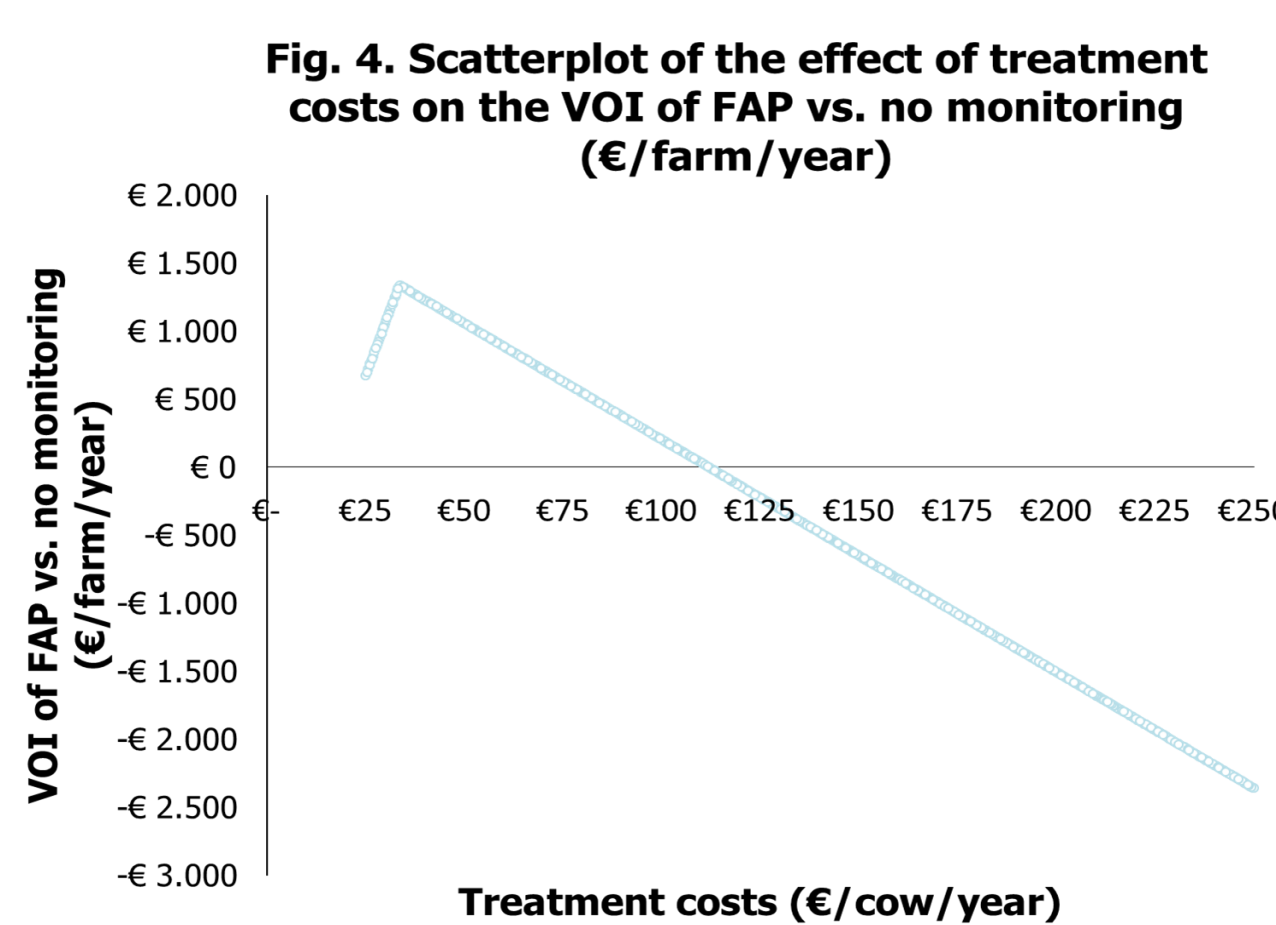
At most likely disease cost (210 €/cow/y) and most likely prevalence (16%), the value of FAP decreases with treatment cost and becomes negative at a treatment cost of 115 €/cow/y.

Fig. 5. Percentage of positive values of VOI of FAP vs. no monitoring with varying treatment costs and disease costs

At low disease costs, there is a maximum treatment cost after which the value of FAP becomes negative. At very high disease cost, the value of FAP is always positive even for high treatment costs.

Discussion and Conclusions

The results suggest that precision monitoring systems (PMS) have an economic value (1) in larger herds; (2) for health and production issues with medium prevalence; and (3) when treating the issue can lead to more than marginal improvements in economic performance per animal. When one or more of these conditions are not met, the window in which PMS have an economic value narrows. This model can aid precision livestock tool developers to estimate the value of information provided by their tools under investigation and to identify the conditions under which such tools will provide the highest benefits.