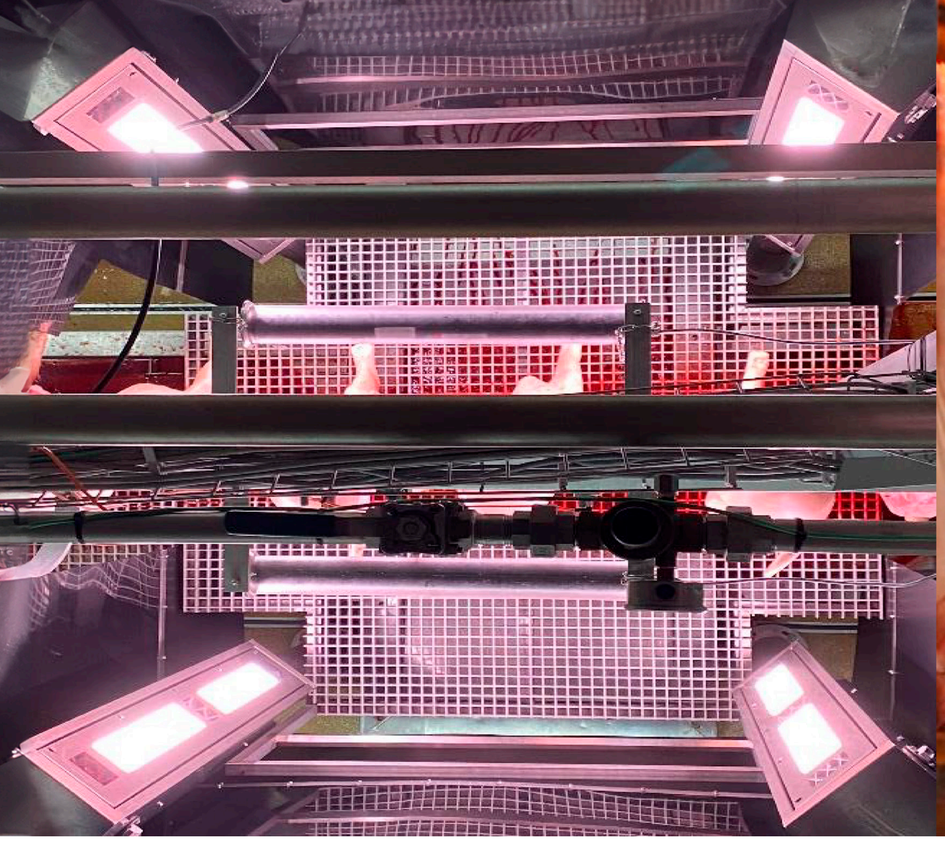

Cameras and AI to enhance the meat inspection process

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Responsible meat production

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AIM

This recent work evaluated the application of computer vision systems (CVS) in detecting fecal contamination on pig carcasses just before the post-mortem inspection phase at the slaughter line. The aim was to explore statistical techniques to evaluate the sensitivity (Se) and specificity (Sp) of CVS compared to official meat inspection (OI) in the absence of a true gold standard evaluation.

MATERIAL

The test CVS was installed inline (top-left picture from above the pig slaughter line), 4 towers each with 3 RGB+NIR cameras taking 24 pictures of each half carcass side. The OI fecal findings were recorded on the main line inspection platform by three OI inspectors.

OI observations were recorded by rotating inspectors according to internal guidelines. Data subsets originating from 15 representative normal production days of a slaughter line, processing at 428 carcasses/h, were collected for analysis and included a total of 71,298 pigs.

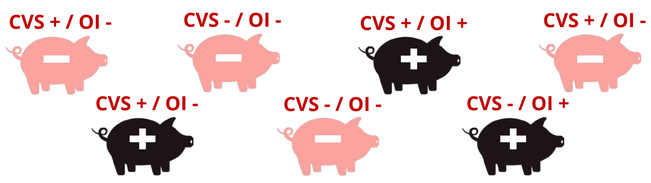
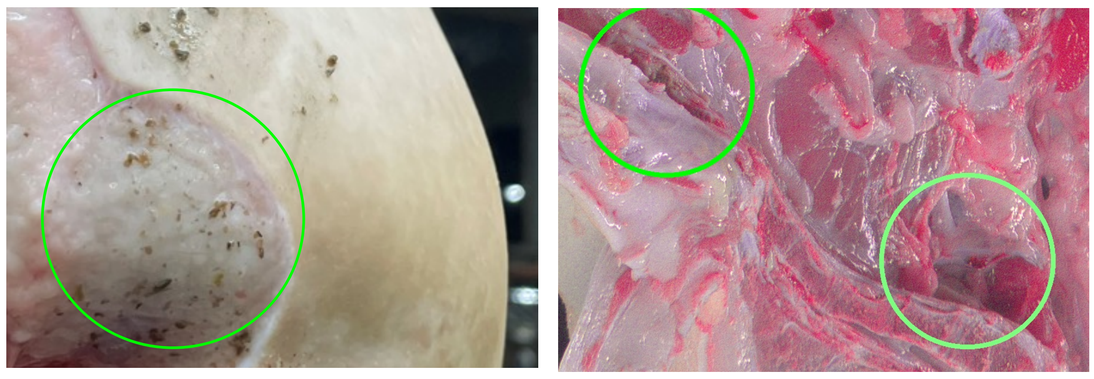


Figure 1 – Illustration of results from two imperfect test (CVS and OI) compared to the pigs' actual fecal contamination status (color and sign)

METHOD

The data was used in a Bayesian latent class model with R, runjags and rjags to estimate Se and Sp. Latent Class Modelling is a statistical method used to classify pigs into "contaminated" and "not contaminated" groups based on the results of two tests, the CVS and the OI, with imperfect results. By analyzing patterns in the test results, the true contamination status of each pig can be inferred. This method helps to improve the accuracy by taking into account the possibility of false positives and false negatives in the test and is considered to be the best method to estimate Se and Sp in the absence of a gold standard.



RESULTS

Through the application of latent class modelling, the Se and Sp of the CVS system were estimated (Table 1). The CVS was better at detecting fecal contaminated carcasses with a Se of 31% versus 20% for the OI. Contrarily, the OI had a near-perfect Sp of 99% versus 97% for CVS, demonstrating that both systems were adept at classifying carcasses devoid of fecal contamination, albeit with a slight edge to the official inspection.

Table 1 – The Se and Sp of both CVS and the OI as estimated by the latent class model. The latent class model's 95% confidence interval is shown in brackets. Also included are the results of using OI or CVS, respectively, as the gold standard

Evaluation group	CVS		Official Inspection (OI)	
	Sensitivity	Specificity	Sensitivity	Specificity
Latent class model	31% [27%-38%]	97% [95%-99%]	20% [14%-26%]	99% [99%-100%]
OI as Gold standard	29%	93%	-	-
CVS as Gold standard	-	-	30%	97%

CONCLUSION

The CVS seems to be more adapt at detecting fecal contamination, helping to improve food safety albeit with a higher rate of false positives.

The latent class model has proven adept at reliably estimating Se and Sp when comparing the CVS and the OI. At present, the utilization of the CVS technology as an aid to enhance detection of contaminations, subject to verification by OI, emerges as a feasible strategy.

CVS and CNN modelling is being iteratively improved with more data and better methods giving promising reductions in false positives, making the technology a robust and uniform way of estimating Se and Sp increasingly relevant.

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