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ANHIWA PigWatch

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Key words
Growing and finishing pigs, injurious behaviour, animal based measures, tail-biting, farmer focus groups

Aim of the study
PigWatch aimed to develop practical animal based measures to avoid the pain, frustration and negative emotional states associated with the development of tail biting and aggression in finishing pigs. It focused on measures for prediction on farm, and for monitoring at the abattoir. A tool should be developed for farmers to help them act quickly and effectively to avoid problems. This will allow corrective actions to be taken before the problem gets out of hand. Secondly, common definitions of injurious behaviours and common scoring methods are needed to benchmark the incidence of the behavioural problems across farms, and also to help quantify the effectiveness of any remedial actions applied over time. That's why the goal at PigWatch was:

- Provide different detection methods conducting to early warning signals for farmers, to help them remedy or prevent outbreaks of tail biting or fighting on-farm.

- Generate routinely collected data at the abattoir on the status of tail biting and aggression on-farm, to allow benchmarking and support measures for farms with relatively high incidences of problems

Material and methods
WP1: The use of animal based warning signals on farm to predict outbreaks of injurious behaviour

Task 1.1 (Leader: WLR, partners: FiBL, INRA, FBN, DMRI) Eye of the stockman
Farmer Focus Groups were set up in the participating countries of the project, consisting of 2-4 farmers per country. They discussed existing protocols for visual observations of injurious behaviours, the 'Eye of the Farmer' protocol. The farmers tested a first version for approximately two months on two farms per country.

Task 1.2 (Leader: INRA, partners: CEA, FBN) Automated assessment of injurious behaviours on farm
The on-farm activity detection monitoring system developed in the PigWatch project consists in a sensor and its electronics embedded in an eartag device, a smartphone with the PigWatch App for data acquisition from sensors, including a machine learning algorithm able to automatically recognize different predefined pig's behaviours and send an alert to the farmer when the target behaviour is detected, namely injurious behaviours in this project. Several intermediate development and test steps have been performed at INRA Rennes. The first pilot test was done on 4 animals in order to get feedback on the use of the sensor itself (acceptability by animals, robustness, practical aspects for the farmer). Following this initial pilot experiment, 12 animals were fitted with eartags and were observed by video cameras during 10 weeks. During this step, the database dedicated to algorithm development for the automated assessment of injurious behaviours has been collected. Behaviour records obtained through video were compared to the sensor data, allowing algorithms to link sensor data and video observations to be developed. The animals were subjected to a mixing period to provoke aggression. After developing the algorithm and optimizing the eartag, a pre-test of the final demonstrator was performed on three animals during one month. Animals were also video-monitored. Around 100 SMS alerts were sent by the system. INRA concluded that one weak point of the system was the sensors connection to the smartphone and recommended a regular check of the system in order to ensure the best running. Last improvements were then done and the final demonstrator was installed at FBN in Dummerstorf where 20 animals (in two boxes) were fitted with eartags and

recorded during 2 months. The system was also tested in two commercial farms (4 pigs in each one) close to FBN during few days. Unfortunately, during this final step, several technical problems occurred that prevented a successful conclusion of the experiment. However, a lot of data were recorded with several eartags, and around 70 SMS alerts were sent by the system. All these new data were then integrated in the algorithm training & testing procedure for further optimization.

Task 1.3 (Leader: INRA, partner: FiBL) Automated assessment of lesion on farm

This task aimed to detect haemoglobin on live animals in an on-farm situation. This approach uses digital pictures of pigs, taken by a multi-spectrum camera. This is a brand new technique: everything had to be developed and was not based on previous material or results. A prototype of the camera was built and an algorithm to process the images was written. The detection method is based on a method described by (Goel et al., 2015). Six images are acquired by an active camera with projection of light characterized by 6 different wavelengths. These wavelengths were chosen so that haemoglobin could be specifically absorbed and detected, at least by one wavelength. The images are taken successively in a very short interval of time (30 ms) so that that they can be superimposed on top of each other. These images are analysed by an algorithm, which allowed to produce a white and black image where pixels in black corresponds to skin lesions with blood and pixels in grey to the skin without blood. Thereafter, the percentage of the skin covered by blood is calculated as the ratio between black pixels and (black + grey) pixels. First images of skin lesions were collected by INRA in their experimental farm (F-35590 saint-Gilles) and were interpreted using haemoglobin detection. A protocol for the detection of skin lesions on live animals was finalised. A bachelor student from Switzerland came to France to be trained to the use of the camera and, the material was sent to Switzerland. Thereafter, 279 pictures were taken in three Swiss commercial farms and sent to France for interpretation. Most of them were of low quality due to saturation problems when illumination was too high or blurring when animals were moving. Only 12 images could be interpreted.

Task 1.4 (Leader: FiBL, partners: INRA, WLR, DMRI, FBN) On-farm application across participating countries

The ‘Eye of the stockman protocol’ (EFP) (developed in T1.1) was translated and presented as a draft instruction leaflet to the Farmer Focus Groups and approved. The EFP was presented to several farmers in and out of the Focus Groups. In 10 farms in total the EFP was tested: 2 farms in Germany, 2 farms in the Netherlands, 2 farms in Denmark, 1 farm in France and 3 farms in Switzerland. Four farms were organically managed, six conventional. Most of the farms see the pigs twice a day during feeding time. All of them, except one, mentioned that they have tail biting problems. The incidence was varied from 10 – 100 % tail biting in a group.

In Switzerland, the testing phase was accompanied by a one-day training course featuring an external consultant specialised in ‘pig signals’: behavioural expressions that can be used to adjust pig management. In the course of the project, a programme was developed to motivate the farmers involved in the project to improve their animal observation skills. It included a supporting package with regular newsletters, a commercially available book called ‘Pig Signals’ and a set of short videos (available on the PigWatch website https://pigwatch.net/). These efforts are not described in the work plan and are extra to what the consortium committed itself to.

WP2 The use of animal based measures to monitor lesions at the abattoir

Task 2.1 (Leader: DMRI) Automated detection of tail lesions at the abattoir

This task developed a system that automatically determines tail length of carcasses at the abattoir. At the start, a reference-scoring card was agreed by the experts involved in the assessment of tail length and lesions. Sensor and software development were started with the specification of the basic in line requirements: the placement of the equipment on the slaughter line, the requirements for data management (data system integration) and the maximum equipment cost. Images from carcasses at the slaughterline were used to develop an algorithm to determine the tail length.

Task 2.2 (Leader: INRA, partner: FiBL) Use of automated lesions scoring during lairage

Initially, it was planned to test the camera for skin lesion detection that was developed in T1.3 also in the lairage of a commercial abattoir in Switzerland. However, due to the low quality of the results obtained in the commercial farms in Switzerland (T1.3), it was decided to send back the material for improvement and new tests in France. The whole system, including the image capture and processing, was modified to reduce the time duration for the full image collection (animal lit 6 times with led lamps of different wavelengths + once without led lighting) and improve the accuracy of the image processing.

Task 2.3 (Leader: DMRI, partner: WLR) Implementation and validation of tail lesion scoring at the abattoir
The prototype system of T2.1 should have been implemented on two commercial slaughter lines (DK and NL) and the effect of feedback to the farmers evaluated during one year of operation. This has not happened, due to serious financial constraints of the Danish partner.

Results and significance

Task 1.1 Eye of the stockman
The results of the Farmer Focus Groups are presented in deliverable D1.1 (see final report of PigWatch), as a standardised protocol to measure injuries behaviour. An important outcome of this task is that to achieve the desired effect, farmers need to be convinced that it works and is worth investing time in. The 'attitude' towards recording changes in behaviour is at least as important as the required technical skills to detect changes. The protocol and these findings were then used in T1.4, as planned.

Task 1.2 Automated assessment of injurious behaviours on farm
To date, the algorithm achieves an accuracy of 75%, a recall (sensitivity) of 51% and a specificity of 99.5% for identifying fighting behaviour, the target injurious behaviour in PigWatch project. Comparison between model performances obtained on the training dataset and the test dataset shows that the model is robust to new data and therefore, achieves good generalization abilities. Increasing the training dataset with new annotated data should improve further this model.

Task 1.3 Automated assessment of lesion on farm
An important conclusion from this Swiss trial is that the technics cannot be used when illumination is too high.
To solve this problem, two types of solutions can be used: sources of natural light should be closed or animals should be moved to a lower lighten area. In addition, this experience showed that the technics should be improved to reduce the time interval between two successive images. By new technical development, it will be possible to reduce the time interval to 14 ms in order to avoid blur when animals are moving. In addition, robustness of the whole system should be improved to allow easy use and cleaning on farms. Analysis of the processed images showed that most of skin lesions with fresh blood were depicted (good sensitivity) but that there were a high number of false positive lesions (low specificity). Therefore, the algorithms will be further improved to avoid false positive lesions without lowering the sensitivity of the detection.

Task 1.4 On-farm application across participating countries
While starting with the project, some of the farmers inspected their feeding and drinking systems and fixed errors or poorly functioning systems. Some farmers with high incidence of tail biting did not start with the checklist because of workload. They were not willing to spend the time observing the groups more closely, not to mention completing the checklists. This in turn shows that tail biting is often a problem where little time is spent observing animals.
Five farmers mentioned after the testing period, that they implement the observation of the tail posture in the daily work. Three farmers observe in addition the ears, activity, general lesions and eyes. The aim of the project was for the participating farms to keep records for one year. However, since the EFP is not actually intended to be carried out in writing, but through the farmer's observation, the observation was often stopped earlier.
In summary, it can be said that the EFP can prevent an outbreak of tail bites. However, the animals must be observed during their activity phase or at least twice a day to prevent an outbreak. On farms with intensive animal care, EFP is a good tool. Many participating farmers were looking for long-term solutions to their problem in addition to short-term intervention. The educational work provided by the Awareness Program often led to further changes in attitude, management and observation.

Task 2.1 Automated detection of tail lesions at the abattoir

With the developed TailCam camera, injury frequencies at the herd level can be determined. TailCam can auto-generate reports for the individual farm, showing the tail length distribution, and the prevalence of “Lesions” and “Small Lesions”, “Short tails” (default <10 cm) and “Very short tails” (default <5 cm). The report is supplied with pictures of all tails affiliated with the four categories, so it is possible to check if the results are correct. The “Farm report” is just one example of the reporting options.

This system was tested and the calculated values for tail length compared well to the measured values, because the calculated lengths were centred around the measured length. Furthermore, most calculated values deviated less than 3 cm from the measured length.

Regarding tail bites, no serious tail bites (“Lesion”) were classified as “No lesion” or vice versa. However, some tails assessed as “Small lesions” were misclassified as “Lesion” or “No lesion”. The sensitivity of “Lesion” was 61% (44), meaning that 39% (27) of true “Lesion” tails were classified as “Small lesion” by TailCam. The sensitivity of “Small lesion” was 75% (146), meaning that 3% (6) were misclassified as “Lesion”, and 22% (42) as “No lesion”. The specificity of the algorithm was 96% (579). This means that 4% (26) of the tails completely free from visual signs of tail bites were misclassified as “Small lesion”. This may seem like a small proportion, but in herds/subpopulations where tail bites are rarely seen, the proportion of 4% of the tails misclassified as “Small lesions”, may disturb the image.

Task 2.2 Use of automated lesions scoring during lairage

After improving the camera in France, 37 images were taken on live animals in the lairage area and 40 images on carcasses in the experimental slaughterhouse from INRA. Results showed that skin lesions with fresh blood can be correctly detected both on live animals and carcasses, even though some adjustments and validation are still need.

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