Analysis of Sequences in Aggressive Interactions of Pigs for the Development of an Automatic Aggression Monitoring and Control System

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Introduction

Aggression is one of the most significant welfare problems when pigs are grouped in our modern production systems. When introduced to unfamiliar conspecifics, pigs naturally engage in aggressive interactions to determine their social hierarchy status [4]. Ordinarily, when the hierarchy is already established in a group, levels of aggression should be relatively low [15]. However, conditions of confined environment like limited space allowance [19], feeding systems promoting competition [13], barren environment [5], low fibre feed composition [16] and repeated changes in group composition [13] can result in persistent aggression. The most obvious negative impact of aggression is the skin lesions - which are often seen on the head, ears, shoulders, flanks and hindquarters [11, 14]. In terms of internal physiology, aggression results in activation of the sympathetic-adrenal-medullary axis and the hypothalamic-pituitary-adrenal axis, resulting in increased heart rate [12], increased plasma cortisol concentrations, increased plasma epinephrine and norepinephrine levels [13]. Besides the negative impact of aggression on health and welfare of pigs it results in lower productive performance, by increasing return to oestrus rate in adult sows [3,17] and by decreasing growth rates of growing pigs [18]. Although the problem of aggression was investigated by many researchers, there was no successful, long term, practical solution developed for lowering aggression level among pigs. There is a necessity for more basic studies in order to understand the phenomenon properly [10] and new solutions must be developed to the problem of aggression among pigs. Basic studies on pig aggression reveal that during a contest, animals successively sample bits of information concerning their relative fighting ability, by observing displays or otherwise gathering relevant information through the behaviour of the opponent. Therefore, when a sufficiently certain assessment cannot be achieved by means of a particular display, the animals will switch to another type of behaviour with a higher information return. This will cause a contest to proceed through a number of different phases, each with a typical behavioural characteristic. Each new phase will consist of more costly behaviour and the last phase will consist of direct sampling of actual fighting ability, through overt, dangerous fighting [10]. Therefore identification of patterns in gradual development of aggressive behaviour should allow for prediction of highly damaging aggressive behaviours expressed in the final phase of these interactions. In order to stop (prevent) these behaviour among pigs with automatic monitoring and control system (PLF –Precision Livestock Farming) we defined the following objective for this research: Identification of differences between aggressive sequences that lead to highly damaging biting behaviour and those that don’t lead to this behaviour.

Aggression monitoring and control by PLF technology

Automatic monitoring and control system of pig aggressive behaviour by utilization of Precision Livestock Farming (PLF) technology offers possibilities for permanent management of highly aggressive attacks. PLF is currently regarded as the heart of the engineering endeavour towards sustainability in (primary) food production. Its application allows making optimal use of knowledge and information from the animal in the monitoring and

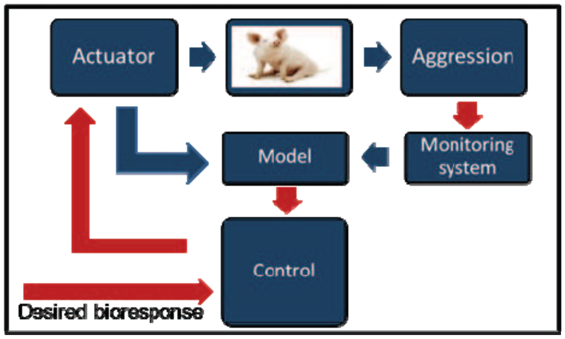

Figure 1. Aggression control by PLF.

control of processes [1]. Application of PLF technology as an automatic aggression monitoring and control system offers a new, unprecedented possibility to effectively lower aggression level among pigs. An integrated automatic monitoring and control system is one which collects information from a variety of sources, including sensors, databases and knowledge bases, processes the data and provides outputs, which may be recommendations to the producer, or direct process control actions [7]. The basic component of aggression monitoring and control system is an automatic monitor which by dynamic analysis of the individual interactions between animals will be able to detect aggressive attacks automatically. The second component of the system is an automatic control which by utilization of an actuator (i.e. sound, smell) will change pigs behaviour in a way that aggression level will be reduced (Figure 1). The strategy for monitoring and controlling of aggressive behaviour among pigs developed in accordance with PLF concept (Figure 1) comprises in using the aid of modern technology in order to develop online tools that can identify detailed animal behaviours in an automatic and continuous way, with an accuracy that allows detecting specific behavioural aspects. When the system automatically detects early signs that are used for predicting when the animal is entering in a particular status that leads to aggressive behaviour, it will use various triggers as actuators, such as light and sounds, to attract and redirect the animals' attention. An automatic reward mechanism, such as provision of food, will also be used to straighten animal responsiveness and to control their behaviour [2]. The most effective actuating mechanism will be chosen in a selection procedure comprising of series of practical experiments. The innovative approach is the development of a real time monitor that allows redirecting undesired livestock behaviour.

Materials and Methods

An observation was carried out at a commercial farm, in practical conditions, during 3 days after mixing on a group of 11 male pigs weighing on average 23 kg and kept in a pen of 4m x 2.5m. A total of 8 hours of video recordings were taken during the 3 days with a top-view camera in the pen and manually labeled afterwards. The video recordings were performed using a camera (Allied Vision Technologies®, model F080C) with 4.8 mm lens, placed above the pen in central position at a height of 2.3m, that permitted a top view image of the whole pen. Colour images were captured with a frame rate of 11 frames per second with a resolution of 1032 x 778 pixels. The videos were stored in a computer for later analysis. Each day a number of video recordings were registered (day 1: 2 h, day 2: 3 h, day 3: 3 h). Data obtained as a result of the visual analysis of the video recordings (labelling procedure) were carefully analyzed in order to identify sequences in pigs aggressive behaviour. An aggressive sequence was defined as a series of aggressive interactions following one after another, between at least two pigs. Successive aggressive behaviours had to be performed by the same pigs - within 30 seconds time period - to be labelled as part of the same sequence. Within aggressive sequences an initiating phase (nosing phase) was distinguished. The phase was defined as consisting of nose to nose, ear chewing and mounting behaviours [6,8,9,10]:

Nose to nose - the nose approaches the snout or head of the receiver
Ear chewing - chewing movements while the ear of a pen mate is in the mouth
Mounting - mount with front legs on the back of another pig while hind legs stay on the ground

Results and Conclusions

A total of 157 sequences of aggression were observed during our observations. Out of which 100 (63.7%) were classified as sequences that didn't lead to biting behaviour and 57 (36.3%) were classified as sequences that led to biting behaviour (Table 1). Duration of sequences that led to biting behaviour was longer (38.8 s, P<0.01) than of sequences that didn't lead to biting behaviour (18.1s) (Table 2). Initiating phase of sequences that led to biting behaviour was lasting for 3.3 s while of sequences that didn't lead to biting behaviour 1.9 s (Table 3).

We identified a difference between duration of aggressive sequences that led to biting behaviour and those that didn't lead to this behaviour. Duration of sequences that led to biting behaviour was longer (38.8 s, P<0.01) than of sequences that didn't lead to biting behaviour (18.1 s). The observed difference is an indication for the automatic monitoring and control system of pig aggression that aggressive sequences lasting longer are more probable leading to biting behaviour. Although not fully significantly, it was observed a trend (P=0.07) in longer duration of initiating phase between sequences that led (3.3 s) and didn't lead to biting behaviour (1.9 s). This finding might be utilized for the automatic, sensor based, early detection of severe aggression. Intervention into pig's behaviour with PLF technology in accordance with the strategy developed [2] could be applied in the early phase of aggressive interaction – during or just after the initiating phase of aggressive sequence.

Table 1. Number of aggressive sequences

Type of sequences	Number of sequences	
	N	Percentage
Sequences that didn't lead to biting	100,0	63,7%
Sequences that led to biting	57,0	36,3%

Table 2. Duration of aggressive sequences

Type of sequences	Duration of aggressive sequences	
	Mean (s)	SEM (s)
Sequences that didn't lead to biting	18.1^{A}	4.3
Sequences that led to biting	38.8^{B}	5.7

(A, B) values differ for P<0.01.

Table 3. Duration of initiating phase of aggressive sequences

Type of sequences	Duration of initiating phase	
	Mean (s)	SEM (s)
Sequences that didn't lead to biting	1.9^{a}	0.4
Sequences that led to biting	3.3^{b}	0.6

(a, b) values differ for P=0.07

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