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Berl Münch Tierärztl Wochenschr 126,
104–112 (2013)
DOI 10.2376/0005-9366-126-104

ISSN 0005-9366

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Eingegangen: 09.05.2012
Angenommen: 18.09.2012

Online first: 08.03.2013
http://vetline.de/zeitschriften/bmtw/
open_access.htm

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Tail Biting in pigs – Causes and management intervention strategies to reduce the behavioural disorder. A review

Schwanzbeißen beim Schwein – Ursachen und Managementstrategien zur Reduktion der Verhaltensstörung. Eine Literaturübersicht

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Summary

One of the largest animal welfare problems in modern pig production is tail biting. This abnormal behaviour compromises the well-being of the animals, can seriously impair animal health and can cause considerable economic losses. Tail biting has a multifactorial origin and occurs mainly in fattening pigs. High stocking densities, poor environment and bad air quality are seen as important factors. However, it is presumed that a plurality of internal and external motivators in intensive pig production can trigger this behaviour which is not reported in sounders of wild boars. The aim of this review is to summarize the causes and the effects of tail biting in pigs and present management strategies that are likely to reduce its incidence. In particular, management strategies by applying Precision Livestock Farming (PLF) technologies to monitor and control the behaviour of the pigs may be suitable to detect the outbreaks of tail biting at an early stage so that counter measures can be taken in time.

Keywords: pig, abnormal behaviour, tail docking, environmental enrichment, automatic monitoring

Zusammenfassung

Eines der bedeutendsten Tierschutzprobleme in der modernen Nutztierhaltung ist das Auftreten von Schwanzbeißen beim Schwein. Diese Verhaltensstörung beeinträchtigt sowohl das Wohlbefinden als auch die Gesundheit der Tiere und kann zudem für den Tierhalter beträchtliche ökonomische Verluste nach sich ziehen. Schwanzbeißen ist ein multikausales Problem und tritt meist bei Mastschweinen auf. Hohe Besatzdichten, eine reizarme Haltungsumwelt und hohe Schadgasbelastungen in der Stallluft gelten als wichtige Faktoren für die Entstehung von Schwanzbeißen. Es wird jedoch vermutet, dass eine ganze Reihe interner und externer Faktoren in der intensiven Tierhaltung diese Verhaltensstörung auslösen kann, die unter Wildschweinen bislang nicht beobachtet wurde. Ziel dieser Review ist es, die Ursachen und Auswirkungen von Schwanzbeißen beim Schwein zu beleuchten und Managementstrategien zu präsentieren, die sich als geeignet erwiesen haben bzw. sich in der Zukunft als geeignet erweisen könnten, um die Inzidenz der Verhaltensstörung Schwanzbeißen zu reduzieren. In diesem Zusammenhang könnte insbesondere die Nutzung innovativer Technologien im Sinne von Precision Livestock Farming (PLF) neue Möglichkeiten zur Früherkennung des Auftretens von Schwanzbeißen im Mastbetrieb eröffnen und so ein frühzeitiges Ergreifen von Gegenmaßnahmen ermöglichen.

Schlüsselwörter: Schwein, Verhaltensstörung, Schwänzekupieren, Haltungsumwelt, automatisches Monitoring

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Code Statement:
0005-9366/2013/12603-104 $ 15.00/0

Introduction

It is a common practice in modern pig production to mix unfamiliar pigs in uniform weight groups directly after weaning and again at the beginning of the fattening period. After regrouping, pigs experience social stress in the new group by rank order fights usually resulting in injured animals (McGlone and Curtis, 1985) and reduced weight gain performance (Stookey and Gonyou, 1994). While such aggressive interactions are considered natural to establish a social hierarchy within the group, there are other observed behaviours interpreted as responses towards unfamiliar situations or stressing conditions. The most detrimental abnormal behaviour is tail biting, which affects the welfare of the animals and the production efficiency of pig production systems. Although the syndrome of tail biting has been recognized at least since the second world war, it was not considered a major problem for a long time (Sambraus, 1985). It seems that with the development of pig production in large units about 60 years ago the problem surfaced and increased in all countries and in all housing systems (Van Putten, 1969; Lindqvist, 1974). This behaviour is essentially a result of modern pig management systems where growing pigs are held at high stocking rates without the opportunities to engage in normal foraging or exploratory behaviours, and where they are often in competition for limited feeder space. It is usually seen indoors, but is also seen outdoors where conditions whilst allowing some exploration and foraging may limit access to important resources such as water or feeder space (Stafford, 2010). Today, four categories are described how tail biting evolves: pre-damage, damage, sudden-forceful and obsessive (Taylor et al., 2010). Considering the large numbers of pigs fattened slaughtered annually, tail biting represents a major economic and welfare problem for the pig industry and, as yet, no adequate solution to this problem has been found.

Economic Losses

Tail biting can reduce production results, increase on farm costs (e.g. labour and treatment costs) and lead to a variety of physical damage and carcass condemnation resulting in financial losses for the farmer and the abattoir (Zonderland, 2010). However, quantitative information on the economic impact regarding tail damage for a pig farmer and the pig sector is scarce, some data can be seen on Table 1.

According to the European Food Safety Authority report (EFSA, 2007), until 2006, the number of farms, mostly without tail docking as a management procedure, with cases of tail biting was in the order of 30–70% and the prevalence of animals with injured tails in these farms was from 1 to 5%. Estimates of farm prevalence range from under 1% to over 10% but individual farms may have figures as high as 20%, and over 60% of farms have been reported to have experienced this problem (Chambers et al., 1995; Hunter et al., 1999). Tail biting, in the worst instance, can lead to cannibalism (Van Putten, 1968) and it is also considered to be one of the greatest contributors to increased production costs and decreasing animal welfare, especially in the nursery and growing units (Fraser and Broom 1990; EFSA, 2007). A Danish study involving 111 herds showed that tail damage, estimated by clinical examination of the herd on the farm, was two times more prevalent than detected by carcass inspection at the abattoirs (Busch et al., 2004). Therefore, it is likely that abattoir records often note only severe cases associated with infection and condemnation. Moinard et al. (2003) estimated that the cost of tail biting in 1999 in the UK was over 4 million Euro due to reduced weight gain, on-farm veterinary treatment, culling and carcass condemnation. A preliminary cost estimation of tail damage among pigs in the Netherlands indicates a financial loss of over 8 million Euro for the pig sector (Zonderland, 2010). This calculation included similar criteria as Moinard et al. (2003) and was based on an average tail biting lesions prevalence of 2,12% (Smulders et al., 2008) for weaned piglets as well as finishing pigs.

Causes

It is known that tail biting has a multifactorial origin, resulting from the interaction of various factors of the environment of the animals. Table 2 shows different causes for tail biting found in different studies (adapted from Schrøder-Petersen and Simonsen, 2001; Moinard et al., 2003; EFSA, 2007; Knoop, 2010).

Tail biting is referred as "abnormal" since it is rarely reported under extensive, semi-natural or feral conditions (Walker and Bilkei, 2006). Intensive husbandry systems limit the expression of some behaviours which domestic species exhibit under less constrained conditions, for instance during farrowing, foraging and social interactions (Graves, 1984; Svendsen and Steen-Svendsen, 1997). As outdoor-kept pigs have less social discomfort, more space allowance and more objects to chew on, according to Bilkei (1994), it seems reasonable to

TABLE 1: *Example of losses caused by tail biting*

Loss	Prevalence	Author
Reduced weight gain	25%	Wallgren and Lindahl (1996)
Carcasses condemnation by abscesses or pyaemia	61–67%	Penny and Hill (1974) Huey (1996) Schrøder-Petersen and Simonsen (2001)
Injured tails at farm level	6,2% and 7,2%	Keeling and Larsen (2004)
Injured tails at slaughter-house	1,9–4,27%	Keeling and Larsen (2004) Hunter et al. (1999)

TABLE 2: *Risk factors for tail biting (TB)*

Risk Factor	Characteristics
Gender	Females tail bite more than castrated males and males are more tail bitten than females
Herd Size	Large herds increase TB
Density	High stocking density increases TB
Age and weight	Probability of occurring TB increases with the age of the animals
Floor	Compact floor in combination with straw tends to reduce TB
Feed	Food quality, quantity and type of presentation can increase TB
State of health	Respiratory problems increase 1.6 time the chance of occurring TB
Enrichment	Toys can help to reduce TB when offered alternately
Air quality	High level of ammonia (>10ppm) increases TB
Genetics	Landrace is suggested to be less susceptible to tail bite

presume that outdoor pigs would not express tail biting behaviour, however, the same author presented a study where outdoor pigs did suffer from tail biting (Walker and Bilkei, 2006). It is possible that the occurrence of tail biting is also related to genetics of modern domestic pig breeds. However, the importance of these genetic effects is not yet fully understood. In past decades, there have been studies where a genetic basis for other behaviours, which may be related to tail biting, has been shown. Knap and Merks (1987) and van der Steen et al. (1988) showed that maternal aggressiveness towards piglets is heritable, while Lund and Simonsen (1995) found Danish Landrace gilts to be more aggressive than Duroc gilts. The heritability of social ranking has also been reported by Jonsson (1985). According to an investigation done by Breuer et al. (2003), Duroc pigs are more active and investigatory than Landrace and Large White pigs, performing more rope-directed behaviour and biting of pen mates, tending to nose pen mates more often. Landrace pigs tend to be more passive in the tail-chew test and are observed to be engaged in harmful social behaviours such as biting and nosing of pen mates less often than the other breeds. Therefore, there is evidence for a genetic basis for the expression of aggressive, foraging and exploratory behaviours, all of which may be associated with the development of tail biting in pigs. Such abnormal and maladaptive behaviours may arise in systems where natural behaviour is constrained (Moinard et al., 2003). It is assumed that tail biting results from the pigs natural tendency to root and chew on objects in their environment, during both foraging and exploratory activity and where tail biting occurs, it is often only a single animal which initially expresses the behaviour against other non-biting penmates of similar breed, and with similar nutritional and housing provision (Van Putten, 1969; Graves, 1984; Stolba and Wood-Gush, 1989; Edwards, 2006). Dietary fibre has been observed to reduce behavioural problems that are, at least in part, related to insufficient satiety in restrictedly fed animals, e.g. breeding sows. Apart from stimulating nutritional satiety, dietary fibre may also satisfy specific behavioural needs related to natural feeding habits such as rooting and chewing in pigs (Meunier-Salaün et al., 2001). Straw may not only increase satiety but also the total time spent processing and ingesting food. According to Lawrence and Terlouw (1993), feed restriction and the impossibility to demonstrate foraging behaviour are considered as the main reasons for the development of oral stereotypic behaviour among sows. Leeuw et al. (2008) reported that highly-fermentable fibres prolong satiety and reduce feeding motivation of growing pigs and sows for many hours after feeding. However, it has been demonstrated that the effects of dietary fibre on satiety and feeding motivation depend on specific characteristics of fibre sources used. One more aspect suggested to cause tail biting is the kind of ventilation used in the stable. Hunter et al. (2001) found that the ventilation type had a significant effect on the probability of tail biting, where natural ventilation, compared to artifical ventilation, reduced the probability of tail biting, being the effect more relevant for long-tailed pigs. There is also a supposition that female piglets are more likely to tail bite than male piglets, however, the reason why female piglets are more likely to tail bite is not clear. Sambraus (1985), Simonsen (1995) and Schrøder-Petersen and Simonsen (2001) speculated that as female pigs start to become sexually mature, they become more active and also more interested in ano-genital investigation. Furthermore, pigs have been observed to perform more ano-genital manipulation before and after tail-in-mouth behaviour than any other behaviour (Schrøder-Petersen, 2005). The higher motivation of female pigs to direct their ano-genital behaviour to the opposite sex can explain the higher tail damage among male piglets compared to the females in our mixed sex groups (Schrøder-Petersen and Simonsen, 2001). Furthermore, Breuer et al. (2003) investigated the manipulation motivation of weaned piglets and found that females had a tendency to manipulate a rope more often than the intact males. On the other hand, Zonderland et al. (2010) observed higher tail damage when tail biting starts to appear among the piglets, but at the end of the experimental period, no difference between all-female and mixed sex groups was found. This higher motivation to perform manipulating behaviour and/or higher motivation to perform ano-genital behaviour among female piglets could explain the higher tail damage development in the all-female groups. Even though the origin of tail biting is not fully understood, tail biting is considered to be an abnormal, pathological behaviour as it occurs mainly, but not exclusively, in pigs kept in barren environments (EFSA, 2007). Some information is known about the time of day tail biting is likely to occur. Haske et al. (1979) suggested tail and ear biting were more frequent before midday. Pigs are normally more active during daylight hours, possibly explaining this result (Fraser and Broom, 1990). Although the behavioural reaction of the bitten pig may help to precipitate increased biting, the availability of blood on the injured tail could also serve as an attraction. In particular, if certain pigs have a strong attraction to blood, this can explain why the initial wound of a tail can trigger a sudden escalation of biting. Consideration of the diverse behaviour patterns that are grouped under the heading 'tail-biting' may reveal different aetiologies of the problem, and may therefore indicate different ways in which they should be resolved. The most common and most effective countermeasures against tail biting are discussed in the following paragraphs, as well as future options to reduce the incidence of tail biting using Precision Livestock Farming techniques (PLF).

Prevention – Tail docking

Docking of the tail is performed in the first days after the piglet is born and the commonly used tail docking techniques include surgical tail docking or heated docking iron (Sutherland et al., 2008). For approximately 50 years, tail docking has been a largely successful practice to discourage tail biting by amputating the distal part of the tail. Ample evidence for the benefits of docking has been provided (McGlone et al., 1990; Hunter et al., 1999 and 2001; Sutherland et al. 2009). One hypothesis why docking prevents tail biting, could be that the nerve regeneration, which follows docking, creates hypersensitivity and so pigs with docked tails will react more readily and more vigorously to assaults on their tails (EFSA, 2007). Simonsen et al. (1991) found as possible evidence of increased sensitivity to pain, that the end of the amputated tail includes regressive changes of the peripheral nerves and formation of neuromas in some pigs. Chermat (2006) has observed that less than 5% of docked piglets, from mild to severe docking, reacted to tail assaults, with aggression or more than avoidance, when there was no lesion on the tail, whereas 70% showed a reaction when the tail presented a lesion. Therefore, even when the tail is docked, most pigs do not seem to react actively unless a lesion is present. Physiological indices of stress have shown increased responses of tail docking, including cortisol concentrations (Mellor and Holmes, 1988; Petrie et al., 1996; Graham et al., 1997; Kent et al., 1998), haematological values (Schreiner and Ruegg, 2002) and haptoglobin concentrations (Eicher et al., 2000). However, Prunier et al. (2005) did not observe any clear changes in plasma profiles of cortisol and ACTH during the first 3 hours following docking in one-day old piglets. Therefore, it seems likely that tail-docking of day-old piglets does not induce a major physiological stress response, although these animals may be capable of showing such reaction. Behaviours, on the other hand, seem to change as a result to tail docking, e.g. reduced feed intake (Eicher et al., 2000), restlessness, foot stamping, head-turning, total active behaviour, time spent in abnormal postures (Graham et al., 1997 and 2002; Kent et al., 1998), vocalisation, tail wagging and tail jamming (Noonan et al., 1994). There are several arguments against tail docking. One argument is the risk of infection, despite being a very rare sequel to docking (Haarbo et al., 1966) and much more common in tail bitten animals (Hagen and Skulberg, 1960; Huey, 1996). Another argument offered by Colyer (1970) and Fraser and Broom (1990), is that the attention of frustrated potential biters may be redirected to other parts of the body of pen mates, such as ears and legs. This might lead us to another hypothesis for the preventive effects of docking, which is that if the pigs have only three to five centimetres of tail, then it is extremely difficult for the tail biter to get hold of the tail so it is possible that short-docked tails are less likely to be bitten (Jackisch et al., 1996; Schrøder-Petersen and Simonsen, 2001; Moinard et al., 2003; Thodberg et al., 2010). However, tail docking can be less welfare reducing for the animals than tail biting (Guise and Penny, 1998), possibly resulting in a slow and painful death for the bitten animals (Van Putten, 1969; Fritschen and Hogg, 1983). A study done by Van de Weerd et al. (2005) showed that 36% of the pigs with undocked tails (both bitten pigs and biters) in the part-slatted building had to be removed from the study as a consequence of tail biting. According to the EU Directive 2001/93/EG, tail docking is only allowed under veterinary prescription, however, it is still considered a routine management procedure in intensive piggeries to prevent tail biting. Tail biting is sporadic, making outbreaks difficult to predict and understand, even within the same facilities and under similar management systems (Sutherland and Tucker, 2011). Tail docking should be used as a supposedly curative solution on problematic farms. The farmers' response to tail biting is to cut the tails shorter, however, it does not prevent tail biting completely (Moinard et al., 2003; EFSA, 2007). Different studies at slaughterhouses showed that the percentages of tail lesions in undocked pigs ranged from 7.4% to 11.6%, whereas the percentages of tail lesions in tail docked pigs ranged between 2.4% and 3.1% (Guise and Penny, 1998; Hunter et al., 1999 and 2001; Beattie et al., 2001). Also the offer of straw cannot completely prevent tail biting. In housing systems where straw was provided, 1.2% of docked pigs showed tail lesions whereas 4.3% of undocked animals showed evidence of tail biting (Hunter et al., 2001). Thus, tail docking has been proven to be an effective measure to reduce the occurrence of tail biting. However, it has to be pointed out that tail docking is suitable to prevent the symptoms of a behavioural disorder, but it does not resolve the causes of this detrimental abnormal behaviour of pigs kept in intensive housing systems.

Prevention – Environmental enrichment

According to EFSA (2007) the most important risk factor for an outbreak of tail biting is the lack of straw or other environmental enrichment in intensive animal housing systems. For this reason, environmental enrichment has been recommended on pig farms being an important requirement for the welfare of the animals, which are often kept in tedious environments. Preventive methods such as the provision of iron chains, pieces of wood, ropes, salt blocks or supplementary food, have been tried. It is known that such stimuli occupy the pigs for a period of time, redirecting their attention from other pen mates. For this reason, the Scientific Veterinary Committee of the European Commission (SVC, 1997) recommended providing to the pigs materials for investigation and manipulation, which can be bedding material or earth floors suitable for rooting. In 2001, the European Commission adopted a directive in which states: "Pigs must have permanent access to a sufficient quantity of material to enable proper investigation and manipulation activities, such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such, which does not compromise the health of the animals" and, since January 2003, the provision of appropriate environmental enrichment to pigs of all ages has been mandatory across the European Union (EU) by the Directives 2001/88/EC and 2001/93/EC. However, this Directive leaves considerable room for interpretation as it is not clear what "proper investigation and manipulation" is. Furthermore, the value of enrichment material is not only determined by the type of material as listed in the Directive, but also by the amount and frequency in which this material should be provided, hygiene, destructibility and responsiveness, e.g. moving or making sounds in response to an interaction with the object (Bracke, 2007). The behaviour of pigs in an alternative enriched system was studied in a series of experiments (Beattie et al., 1995, 1996 and 2000a, b). The size and design of the pens were similar throughout, as were the behavioural observation techniques used. When the behavioural time-budgets in the alternative housing system enriched with litter were compared with a barren control group, differences in the levels of exploration, aggression and harmful social behaviour were detected. Pigs from enriched pens spent up to 25% of the observed time interacting with the enrichment substrates, whereas pigs in barren systems channelled their activity towards the pen fixtures. Zonderland et al. (2008) found that tail biting is best prevented with a small amount of straw, and to a lesser extent with a straw rack, compared to providing a chain or a rubber hose. Once tail biting has occurred, providing a small amount of straw twice daily and removing the biter appear to be equally effective. When comparing 12 groups of 13 to 16 pigs kept in straw-bedded floor and 12 groups, also with 13 to 16 pigs, in part-slatted floor, Van de Weerd et al. (2005) reported that in straw-bedded pen, a tail biting incident occurred only when straw was not available because it could not be topped up at the usual time. Tail biting stopped as soon as fresh straw was provided. All the 12 groups of pigs kept in part-slatted floor presented tail biting, especially during the finishing period. Hunter et al. (2001) showed that long-tailed pigs with access to light straw and natural ventilation/artificially controlled natural ventilation had a level of tail biting (4.3%), which was approximately half of that in the whole population of long-tailed pigs (8.5%). In addition, pigs in the enriched environment spent less time "inactive while alert" and expressed less "harmful social behaviour" and "aggressive" behaviour (such as head thrusting) than pigs housed in the barren control pens. In particular, the levels of "nosing pen-mates", "ear-, tail- or leg-biting" were reduced. In these studies, pigs housed in the alternative enriched housing systems were provided with up to four times as much floor space as the pigs housed in the barren pens. Therefore the effects of space and enrichment were confounded. Beattie et al. (1996) attempted to address this concern and concluded that the enrichment in the system played a greater role in determining pig behaviour than available floor space. Concerning the meat of animals kept outdoors and in alternative enriched environments, Gentry et al. (2002, and 2004) found no effects of increased exercise on the carcass measurements and meat quality variables such as pH, drip loss, sensory panel, and shear force values. However, pigs from enriched environments had greater levels of backfat than their counterparts compared with pigs from barren environments, and pigs finished outdoors had more reddish pink colour scores than pigs finished indoors (Beattie et al., 2000b; Gentry et al., 2002) Feddes and Fraser (1994) suggested that the most effective toys for preventing tail biting are those which give the pigs an opportunity to perform destructive, non-nutritive chewing in which they alter or remove pieces from an object. Most of the "toys" used by farmers were not easily destructible, for the reason that they last longer and cost less. However, pigs often loose interest in these novel objects as soon as they become accustomed to them, leading to a low level of use and negligible behaviour. In addition, the same authors elucidate that "toys" would be more effective if they were more easily altered, attracting pigs' attention towards them. Especially when no positive reinforcement is attached to the object, the preventive effect may be limited.

Management intervention – common practice and future prospects

Tail biting is a substantial economic and welfare problem in growing and fattening pigs and a considerable amount of research has been done to avoid it. Several studies suggest that environmental enrichment, especially the provision of straw, reduces the chances of having tail biting and also helps when the behaviour is being already expressed among the pigs (Van Putten, 1968; Bøe, 1993; Petersen et al., 1995). Several recommendations have been made once the first signs of tail biting are present, such as providing pigs with lots of straw, extra fresh air, an extra meal or to darken the room (Van Putten, 1968). Schrøder-Petersen and Simonsen (2001) suggested isolation of the tail biter, making possible the identification of such individual, followed by removal of the bitten pigs for medical treatment (Hunter et al., 2001). The signs for a possible tail biting outbreak and the transition to a damaging stage are not well documented until the present moment, but it is generally accepted that at some point, probably during tail-in-mouth behaviour, also depending on the tail posture e.g. curled, hanging or between legs and motion level as intense wagging, wagging or motionless, the manipulation may injure the skin (Fraser and Broom, 1990; McGlone et al., 1990; Schrøder-Petersen et al., 2003; Statham et al., 2009; Zonderland et al., 2009). Once the tail is bleeding, the problem can rapidly escalate as other pigs are attracted to the tail (Fraser, 1987). Measures as lowering the stocking density, improving the air quality inside the stable, increasing feed quality and availability of feeding space were also investigated (Geers et al., 1989; Morrow and Walker, 1994; Day et al., 2002; Moinard et al., 2003; Almond and Bilkei, 2006). However, many applied ethologists feel their findings could be used more extensively in practice. A modelling technique using the available scientific information in a balanced way could facilitate the application of information to help reduce tail biting in pigs (Bracke et al., 2004). This opens up the perspectives for the development of automated monitoring tools using the principles of Precision Livestock Farming (PLF). The success and trust of animal welfare schemes relies solely on the validity, reliability and sensitivity of the measurement tool, and no such tools combining several direct and indirect measurements have been subjected to rigorous evaluation (Scott et al., 2010). A practical and robust tool must be based on relatively simple observations and records related to aspects of husbandry and welfare so that a skilled and trained researcher should be able to gather this information during a single visit. Although simple, such protocols combining several aspects should provide a detailed and valid picture of the welfare status of commercially kept animals (Smulders et al. 2006). Performance records, behavioural, physiological and clinical parameters can be a good basis for assessing welfare at the animal level (Gonyou, 1994; Fraser, 1995) but they also indicated the difficult interpretation of these results and the limited value of performance measures for animal welfare (Meunier-Salaün et al., 1987). However, once a valid animal-based tool is constructed, it can be used to determine on-farm risk factors concerning the provision of resources, as well as management, stockman ship and farm characteristics. For instance, Van Hirtum et al. (2003) and Guarino et al. (2008) developed a tool for recognition of sick pig cough using sound analysis and algorithms have been tested to detect cough sounds and to classify the animals whether they were ill or not. Concerning tail biting, Bracke et al. (2004) developed and validated a decision support system to help assess the risk of having tail biting in a certain production system. Another tool was designed to assess enrichment materials for pigs, and for this reason, a study was conducted to examine the importance of three assessment criteria, destructibility, hygiene and sound, with the objective of verifying how the treatments would affect pig behaviour, how intensity-related measures were related to AMI (animal-material interaction), what this meant for the relative importance of the three assessment criteria, helping on the validation of the model (Bracke, 2007; Bracke and Spoolder, 2008). More recently, the University of Bristol in collaboration with the University of Newcastle developed a Husbandry Advisory Tool (HAT), which is a management tool to identify specific risks of tail biting present at pen level and to provide precise information to tailored advice to address these risks (Taylor et al., 2012), but no data related to the efficiency of this tool is available until the present moment. In Germany, the research group of Schrader et al. at the Friedrich Löffler Institute (Celle, Germany) is currently developing a similar management tool adapted to German pig production standards. The study which includes analyses of the pigs' environment and the incidence of tail biting on 70 pig farms in Germany, will continue until August 2014. Results have not been published yet.

A promising approach could be the development of an image-based automatic monitoring tool which can have the potential to identify the occurrence of tail biting at an early stage, for instance based on activity analyses, on the identification of tail-in-mouth behaviour or tail position changes. Monitoring pig behaviour in a fully automated way can offer new possibilities to identify tail biting outbreaks and would enable the farmer to take countermeasures at an early stage. Up to now there is no such PLF tool available. An automatic monitoring tool to detect aggressive behaviour in pigs is currently being developed within the EU-project "BioBusiness" in which the authors of this paper are involved. The development of the first algorithms for a detection of aggressive interactions in pigs shows already promising results which offers the possibility to provide a monitoring tool for aggressive interactions in the near future. PLF tools also offer new possibilities for a detection of abnormal detrimental behaviours, such as tail biting.

Conclusion

Tail biting is a complex abnormal behaviour, often observed in commercial indoor environments among weaned and fattening pigs. There is a variety of reasons for its occurrence, and it seems to be more present in pens with higher stocking densities, lack of (or low quality) substrate, poor ventilation, deficiencies in feed quality or accessibility, or poor health which makes it difficult to control. Tail-biting has also been recorded in outdoor herds and under organic conditions, nevertheless, in lower prevalence. The commonly practiced method of docking the tails of piglets at the age around three days of life can considerably reduce tail biting. The positive influence of environmental enrichment has also been confirmed. However, the total elimination of tail biting does not seem possible under the current intensive farming systems. There is still a lack of new ideas to design an attractive environment which distracts the animals from injurious interactions as a preventive measure. All too often, tail biting is not diagnosed nor treated until tail damage is present. There is a need to identify predictors of tail damage. One of the promising options seems to be the application of the principles of Precision Livestock Farming (PLF) by the use of image analysis which could have the potential to identify early signs of tail biting e.g. when and how a pig approaches its penmate. First experiments are being performed in the EU Marie Curie Project "BioBusiness". However, there is still considerable research and technological development necessary to reach this goal.

Acknowledgments

This research is a part of the BioBusiness Project and made possible by the support of the EU Commission and Marie Curie Initial Training.

Conflict of interest: The authors declare to have no conflict of interest such as financial and personal relationships with other people or organisations that could inappropriately influence their work.

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