DOI: 10.5433/1679-0359.2016v37n1p525

# Needs and challenges of using enrichment materials in the pig industry

# Necessidade e desafios do uso de materiais de enriquecimento ambiental na suinocultura industrial

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## Abstract

Pigs have certain needs that, when unfulfilled, can affect their behavior and their productive efficiency thus promoting welfare problems. Exploration and the search for food are inherent behaviors in pigs at all stages of production, and nest preparation is an exclusive antepartum need for females. In intensive rearing units, providing environmental enrichment materials is a way to meet these needs that allows the animals to fully express their behavior and avoid problems such as tail biting, stereotypes and, specifically in the case of breeding arrays, the onset of labor due to stress, which can result in impaired births and piglets. Straw is known as an enrichment material that best meets these demands, and it is an important requirement of animal welfare legislation in several countries. This study was developed to highlight the importance of meeting the biological needs of pigs through the provision of environmental enrichment materials and to demonstrate the positive results that these materials have on pig welfare. The challenges to the viability of the regular use of these resources in industrial pig farming are also addressed.

**Key words:** Welfare, tail-biting, stereotypes, nesting, straw, pigs

## Resumo

Os suínos possuem necessidades natas que quando não atendidas afetam seu comportamento e sua eficiência produtiva, promovendo o surgimento de problemas de bem-estar. A exploração e a busca por alimento é um comportamento inerente dos suínos em todas as fases de produção, e a preparação do ninho é uma necessidade exclusiva da fêmea durante o pré-parto. Nas unidades de criação intensiva o fornecimento de materiais de enriquecimento ambiental é uma forma de atender estas necessidades, permitindo que os animais expressem plenamente seu comportamento, evitando problemas como caudofagia, estereotipias e, especificamente no caso das matrizes, o início do parto sob estresse, resultando no comprometimento do parto e dos leitões. A palha é reconhecidamente o material de enriquecimento com as características que melhor atende estas demandas, constituindo um item primordial descrito nas legislações de bem-estar animal de vários países. Assim, este trabalho foi desenvolvido com o objetivo de destacar a importância em atender as demandas biológicas dos suínos por materiais de enriquecimento ambiental; demonstrar os resultados positivos que estes materiais exercem no bem-estar dos suínos, ao mesmo tempo em que são abordados os desafios para a viabilização do uso regular destes recursos na suinocultura industrial.

**Palavras-chave**: Bem-estar, caudofagia, estereotipias, nidificação, palha, suínos

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Recebido para publicação 25/11/14 Aprovado em 01/08/15

## Introduction

When seeking to understand the demands of an animal, the term "need" must be understood as relating to a basic biological condition focused on obtaining a particular resource or a response to a particular environment or body stimulus (BROOM, 2001). In this context, some behavioral needs are essential for maintaining the welfare of pigs because when they are unmet, production is altered and mental suffering results. The behavioral needs that highly motivate pigs are those related to exploration and the search for food, locomotion, nest-building before farrow and social contact (BERGERON et al., 2008). Swine welfare can be quantified through protocols that include measures based on management, the environment and the animal itself (MANTECA et al., 2013).

The freedom to express behaviors that are characterized as normal is one of the five freedoms proposed by the Farm Animal Welfare Council (FAWC, 1992), which provide a practical guide to the basic requirements for appropriate animal welfare. Recently, the Welfare Quality® project determined that appropriate behavior is one of the four principles required for a good quality of life for animals (WELFARE QUALITY, 2009).

The non-recognition of the importance of behavioral needs, such as when the focus is commercial livestock activities, can be counterproductive and prevent maximum productivity. It is accepted that when an animal is able to perform its typical behaviors, this contributes to their biological fitness. However, to demonstrate that a perceived need is actually true, a lack of care must be shown to result in an impairment of welfare with proven negative consequences (BAXTER et al., 2011).

To address a pig's need for exploration and the search of food, which must be met regardless of its stage in the production cycle, and the need for nest-building in females before farrow, environmental enrichment materials should be provided. Straw is a resource that ensures the expression of natural behaviors in species, and it is recommended by animal welfare legislation in various European countries by means of Directive 2008/120/EC (EUROPEAN COMMISSION, 2009) as well as in Australia (PRIMARY INDUSTRIES STANDING COMMITTEE, 2008), New Zealand (NATIONAL ANIMAL WELFARE ADVISORY COMMITTEE, 2010), Chile (CHILE, 2013), and, recently, Canada through the Code of Practice for the Care and Handling of Pigs (NATIONAL FARM ANIMAL CARE COUNCIL, 2014), which recommends a series of procedures to meet the same goals.

However, when presenting the matter to the livestock production sector, there are practical, economic and environmental challenges to full compliance with these welfare requirements. In Brazil, there is no regulation establishing a code of conduct, but industrial pig farming should anticipate these challenges based on the experiences of other countries.

Thus, the aim of this literature review is to discuss the behavioral needs related to exploration and the search of food, which is relevant to all pigs, and the need for nest-building, which is specific to antepartum females. This review also highlights the challenges to the routine use of environmental enrichment materials in industrial pig farming.

## Development

*Need for exploration and foraging*

In intensive production systems, pigs are often housed in pens equipped with few resources designed to stimulate / motivate the animals and are therefore characterized as boring environments. Commonly, these facilities have poured concrete floors and are free of substrates for exploration, which frustrates the expression of normal, highly motivating behaviors, such as exploration and the search for food (VAN de WEERD; DAY, 2009). Therefore, environmental enrichment is

undoubtedly an important requirement for the welfare of animals kept in confined environments (BRACKE et al., 2006).

Pigs in boring environments have higher salivary cortisol levels than those housed in environments enriched with straw, indicating that animals in boring environments can be chronically stressed and possibly develop depression (VAN de WEERD; DAY, 2009).

Enriched environments positively change animal behavior. Pigs that have access to enrichment materials spend more than 25% of their active time exploring these materials, but in their absence, pigs display different postures and redirect their behavior toward their companions or fixate on any object that is part of the bay, even the empty floor. Animals housed in enriched environments engage in fewer harmful social behaviors, such as nibbling other pigs, and are less aggressive than poorly stimulated animals housed in pens (BEATTIE et al., 2000). In bays with drained floors without enrichment materials, pigs reduce the amount of time dedicated to exploration and develop destructive behaviors, such as biting their companions and other items in the bay (AVERÓS et al., 2010).

Health problems, such as tail-biting, may occur when pigs are not allowed to manifest so-called normal behavior. In such cases, many producers partially slice the tails of newborn piglets from one to two-thirds of their length, which reduces the frequency of tail-biting in intensive conditions but does not completely eliminate the problem as long as conditions favorable to the expression of abnormal behavior persist (EUROPEAN FOOD SAFETY AUTHORITY, 2007).

Moinard et al. (2000) evaluated hypotheses related to the origin of tail-biting and found that it can stem from redirected exploratory behavior, i.e., the fruit of bored animals raised intensively, but it can also be a consequence of dietary imbalance, such as limited salt or fiber in the diet, or poor management practices, such as uncontrolled temperature, inadequate ventilation, and high levels of ammonia among others, in the environment or shed. However, a pig's inherent need to explore its environment as part of its eating behavior is considered to be the primary factor motivating tail-biting (EUROPEAN FOOD SAFETY AUTHORITY, 2007). These propositions have been validated, and the risk of tail-biting can be reduced by a factor of 10 through the provision of straw one or more times daily (MOINARD et al., 2003).

Tail-biting is rarely described in swine production under extensive conditions, such as semi-wild boar breeds, that is, it generally does not occur in situations where natural behaviors are not restricted. Temple et al. (2012a) studied the prevalence of tail-biting during the growth phase; 2.5% of cases were observed in conventional systems, 1.4% in pigs raised in place on beds, and 0.1% in intensively reared Iberian pigs confined in stalls. However, no observations were recorded in extensive systems.

Therefore, tail docking may be an appropriate measure to prevent tail-biting in pigs reared intensively, but it does not address the causes of the problem (SONODA et al., 2013). Tail-biting could be considered an indicator of an inappropriate environment requiring improvements in housing conditions, such as the implementation of environmental enrichment strategies, before adopting routine tail docking as part of management (NANNONI et al., 2014). Based on these scientific experiments, animal welfare regulations prohibit routine tail cutting as a preventive measure for tail-biting and recommend other actions, such as the use of enrichment materials.

Tail-biting stereotypies are also a health problem in boring environments but can also be mitigated through environmental enrichment. Mason (1991) defined a stereotypy as any sequence of repetitive movement with an unchanging pattern and no function or apparent purpose. Such behaviors represent a metabolic cost to an animal because they involve energy expenditure without any

benefit. Terlouw et al. (1991a) identified the most frequent stereotypies as biting the bars of cells, the development of chewing movements with an empty mouth, chain chewing and excessive water intake.

Stereotypies are clear indicators of a lack of welfare and are some of the problems that have received the most attention in recent years, especially when dealing with arrays. Stereotypies result from a combination of factors, such as hunger, a lack of welding materials such as straw, and restrictions on movement imposed by cells (MANTECA, 2011). Stereotypies are more frequent immediately prior to feeding and are attributed to a limited supply of nutrients combined with reduced access to manipulable substrates in individual and collective living quarters. This suggests that the environment in which an animal lives promotes the development of stereotypies (TERLOUW et al., 1991b). In such a scenario, supplying straw to pregnant animals can provide one or more benefits: it can provide some nutritional value if consumed; it can offer physical and thermal comfort during rest, and it promotes environmental enrichment, which leads to a reduction in stereotypies and aggressive behavior (BARNETT et al., 2001).

*Environmental enrichment for pigs at all stages*

Environmental enrichment for pigs of all ages is a requirement of many animal welfare standards. Chilean law states that premises must provide environmental enrichment appropriate to the etiology of each species (CHILE, 2013), and the Australian legislation recommends providing straw or other materials for handling to avoid aggression and cannibalism. These materials should allow animals to express food-seeking behavior in addition to providing physical and thermal comfort during rest, but their use must be compatible with the waste drainage system and meet the requirements for cleanliness and the thermal comfort of the animals (PRIMARY INDUSTRIES STANDING COMMITTEE, 2008). The animal welfare code of New Zealand recommends the use of straw or other handling materials for all pigs and stresses the concomitant provision of straw with other measures, such as more food and space, to prevent cannibalism as opposed to systematic tail cutting. Other recommended environmental enrichment practices include "toys," such as hanging chains, stones, tires and balls, positive human contact, and the use of radios in growth pavilions to condition pigs to the noises and voices commonly present on farms (NATIONAL ANIMAL WELFARE ADVISORY COMMITTEE, 2010).

The Canadian legislation recommends that pigs be provided with multiple forms of environmental enrichment, such as straw, hay, wood, sawdust, mushroom compounds, peat or a mixture of these, provided they do not threaten the health of the animals or the safety of the farm. The Canadian guidelines further state that under hazardous waste collection conditions, materials for handling should be suspended above the floor of the stalls, and they highlight, among others, strips of fabric or rubber, dispensers containing straw, and other free objects (NATIONAL FARM ANIMAL CARE COUNCIL, 2014).

The European Union, through Directive 2008/120 / EC established requirements to meet the need for exploration and the search of food; "pigs should have permanent access to a sufficient quantity of material to allow proper investigation and manipulation activities, such as straw, hay, wood, sawdust, mushroom compounds, peat or a mixture thereof, that does not compromise the health of animals" (EUROPEAN COMMISSION, 2009).

With the understanding that pigs, independent of age, need to be kept in environments enriched with objects or substrates for investigation and manipulation to keep them occupied and stimulated and to promote the development of non-harmful behaviors, as required by normative welfare guidelines, some issues remain controversial in

the production sector. Therefore, the following questions apply: What are the materials to be chosen? What are the risks to the animals and the farm? As provide them?

One of the obstacles to the implementation of these measures is that certain substrates named in the regulations could compromise or block the flow of waste systems in farms with slatted or partially slatted floors. Additionally, if the type of enrichment material affects productivity or meat quality, its adoption on a commercial scale can be stopped (VAN de WEERD; DAY, 2009). The use of whole straw is a practical example of these challenges as it requires additional work and some mechanization to remove the parts that are not used by animals (GUY et al., 2013).

Assuming its use is feasible, straw can be provided on the floor as a bunk bed (deep bedding) or alternatively, through dispensers, blocks or beams. This material is most efficiently used in the system when it is renewed or supplied daily and comes in the form of long fibers (BPEX, 2010).

Moreover, the use of straw as an enrichment material has been questioned due to the potential health risks from pathogens (bacteria, viruses, fungi) or the increase in the vacuum level in the environment. However, an analysis of the issue found that the consequences of the use of straw for the health of pigs must be interpreted cautiously so as not to confuse them with the possible health risks from the effects of housing and management. Therefore, one should consider that some illnesses and injuries are more prevalent in housing systems with straw while others occur in environments devoid of this material (TUYTTENS, 2005).

The rearing of pigs on a bed system is an alternative that usually meets the behavioral needs of pigs. Some countries, such as France, have adopted this system in 7% of their fattening pens. Others, such as Spain, make little use of this model, citing incompatibilities with the high ambient temperatures and the limited availability of such enrichment material in the country. In this production system, the excretions are absorbed by the bedding material itself, which demands the removal of the bed plus cleaning. Additionally, the temperature of the straw is higher than the concrete floor, which promotes critical temperatures that may expose the animals to thermal distress (TEMPLE et al., 2012b).

However, supplying 2 kg of straw per pig / week during the fattening stage leads to a high degree of manipulation by the animal and stimulates exploration and food seeking behavior. In contrast, pigs that do not have access to straw spend more time exploring the walls of the bay, the excretions and their companions (SPOOLDER et al., 2000). Providing fresh straw to the animals daily, from birth to fattening, is a proven measure for preventing tail biting (MOINARD et al., 2003) as there is a reduced incidence of undesirable social behaviors and increased expression of species-specific behaviors, such as exploration, food searching and play (VAN de WEERD; DAY, 2009). The greater the interaction of the animals with the enrichment materials, the lower the incidences of ear and tail biting (BRACKE et al., 2006).

Thus, straw is recognized as a premium substrate for environmental enrichment, although there are known challenges to its use (NATIONAL FARM ANIMAL CARE COUNCIL, 2014). The phrase "any amount of straw is better than nothing; 100 g of chopped straw per pig / day is enough to keep them busy" has practical and theoretical foundations. However, when the chaff is not a practical option, producers must provide other enrichment materials, such as "toys" (BPEX, 2010).

Although the substrates listed in the regulations are effective examples of enrichment materials, if they cannot be provided for any reason, what alternatives exist is a recurring, controversial question (VAN de WEERD; DAY, 2009).

In the list of alternatives that meet the aforementioned purposes, the materials described as "toys" by some authors may be suitable as they

provide environmental enrichment. These include objects that provide distractions to animals, such as chains, vehicle tires and plastic objects (PARÉS CASANOVA, 2012).

In this sense, the characteristics of the enrichment materials are important considerations as they are related to the welfare of pigs. Animals are more motivated to interact with objects that are chewable, deformable and destructible, which are characteristics associated with the substrates that animals explore and search for food in nature. In addition, enrichment materials should be functional, easy to use and economical; otherwise, they will be of limited use (VAN de WEERD; DAY, 2009). The degree of novelty is another important feature of enrichment materials because uniqueness stimulates porcine interest (GUY et al., 2013).

The supply of different enrichment materials increases the amount of time that pigs dedicate to different tasks. The most stimulating are those that become more apparent when deformed and that are suspended at the eye level of the animal or on the floor (AVERÓS et al., 2010).

Bracke et al. (2006) ranked enrichment materials by their benefits to animal welfare. In this classification, they are as follows, from less efficient to more efficient: metal objects, mineral blocks, rubber and plastic, ropes and fabrics, forage (hay), wood substrates (compounds, soil, sand, and peat), straw and composites (mixtures). Therefore, metal objects provide little benefit for welfare although they are often used.

Furthermore, animals habituate to materials quickly; the average percentage of time devoted to holding materials from the first to the fifth day of exposure fell from 31% to 6% (an over 80% reduction in interest). The amount of time also declines with the materials used as follows: metal chains (88%), wood chips (72%), sisal ropes (70%) and sand (53%). Therefore, environmental enrichment strategies that use a number of different materials for a few days followed by an exchange for another set of materials with different properties is a valid strategy for motivating animals (GUY et al., 2013). As pigs respond to new, different objects, enrichment materials should be changed at least weekly to maintain interest (BPEX, 2010).

In choosing the best enrichment objects, some additional criteria must be considered, as materials must be safe, free of pathogens, chewable, easily positioned or suspended inside the bay, and easy to handle (NATIONAL FARM ANIMAL CARE COUNCIL, 2014). Pigs usually get bored with indestructible objects; they quickly lose interest in objects covered by waste, and hard objects alone do not constitute enrichment materials. When used alone, chains provide little motivation, and tires, in turn, are not acceptable due to the risk of injury because they contain iron parts that can lead to intestinal lesions (BPEX, 2010).

Enrichment materials and objects must meet certain criteria so as not to compromise food safety on the farm and to avoid health problems, such as strangulation, suffocation, poisoning, digestive tract obstruction, and the transmission of pathogens (MENCH et al., 2010).

*Need for nest-building before delivery*

In industrial pig farming, pregnant animals are transferred to the maternity sector between 3-7 days pre-delivery and housed in individual breeder cells with restricted space and no nest preparation materials. Under these conditions, many environmental (exogenous) stimuli are limited due to the absence of handling materials before farrow.

With the intensification of confinement, which occurred in the late 1950s, and the development of breeder cells, the argument that highly domesticated modern sows no longer had the motivation to build nests with the approach of delivery gained support, which freed swine producers from providing straw to females (ALGERS; UVNÄS-MOBERG, 2007).

However, in spite of domestication, this behavior persists even under intensive production. Nest-building behavior is an important part of the maternal process that exclusively manifests itself pre- and postpartum (WISCHNER et al., 2009), demonstrating that there is motivation to perform seemingly unnecessary behaviors in intensive situations even if there is apparently no reason. Therefore, nesting materials also have important biological significance for the animal (BAXTER et al., 2011).

Nest-building behavior is influenced by endogenous and exogenous stimuli that, when combined, can determine whether nest building will be completed successfully (WISCHNER et al., 2009). It is gradually reduced when oxytocin levels start to increase approximately 6 hours before parturition, and females then enter before delivery to start nest-building in a quiet phase (ALGERS; UVNÄS-MOBERG, 2007).

The positive feedback from the construction and completion of a nest can affect the neuroendocrine regulation of maternal behavior. If a female does not find the conditions necessary to express this behavior, it will continue to demonstrate this activity during labor, which constitutes a stressor that increases the risk of crushing piglets, prolonging delivery and increasing stillbirths (BAXTER et al., 2011).

To engage with this motivation to build nests, it is recommended that earth or sand be provided at least 24 hours before parturition along with straw branches or other nesting materials. As the time of delivery approaches under natural conditions, the female begin nest-building by digging in the soil, creating a shallow depression with her nose. Nesting materials, such as grass, twigs and branches, are collected and transported by mouth to the location of the nest (MENCH et al., 2010).

When materials are available for nest-building, female health and welfare and piglet survival are improved (DAMM et al., 2000). If a female cannot express this natural need due to a lack of material, the nest-building behavior is redirected toward the brood cell and other equipment, which results in stereotypies, stress and poor reproductive performance (WISCHNER et al., 2009).

*Environmental enrichment for females in the pre-farrow stage*

The provision of enrichment materials for the matrices during the prepartum period is a normative requirement of many animal welfare regulations. New Zealand recommends providing materials for nest building, such as straw, from 48 hours before delivery to the time of the delivery itself and notes that breeder cells are not suitable to the expression of this behavior due to the movement restrictions that reduce the capacity for manifestation (NATIONAL ANIMAL WELFARE ADVISORY COMMITTEE, 2010).

In Canada, the law dictates that the headquarters should be moved to the maternity 3-5 days before the expected date of delivery, and a bed / material for nest building should be made available 48 hours before delivery if they do not impede the flow of waste (NATIONAL FARM ANIMAL CARE COUNCIL, 2014). The European Union, through Directive 2008/120 / EC, legally established the need to provide enrichment materials for nesting by stating that by "the previous maternity forecast week, sows and gilts shall have suitable material in sufficient quantity to make a nest" (EUROPEAN COMMISSION, 2009).

Even when pre-built nests are offered antepartum, females demonstrate the innate behavior of nest construction (AREY et al., 1991). Supplying sand to young females pre-birth increases the level of activity and behaviors related to nest construction, resulting in shorter deliveries, more live piglet births, and reduced incidences of intrapartum stillbirths and crushed piglets at birth (CRONIN et al., 1993).

Of course, the freedom of movement in the cell and, especially, the material available for nest preparation affect both the sow and litter. Yun et al. (2013) evaluated three delivery situations: females stuck in farrowing crates + sand until birth preparation; loose females in farrowing crates + sand until birth preparation; and loose females in farrowing crates + abundant material for preparing the nest (straw). The experiment demonstrated clear advantages for the group that had access to abundant materials, and the authors also observed higher levels of oxytocin and prolactin in the third group as well as more careful behavior with the litters. By further observing this group, Yun et al. (2014a) found that females spent more time on nest preparation activities, such as stomping, biting and arranging the material, and the provision of nest-building materials improved the intake of colostrum, which was evaluated during early lactation by quantifying the serum IgM and IgG of the piglets. This had positive effects on survival signaling and the performance of piglets during the farrowing (YUN et al., 2014b). This work highlighted the advantages of straw, but supplying sand as the material for the preparation of the nest may be a better solution in intensive systems when the availability of straw is limited (CHALOUPKOVÁ et al., 2011).

Therefore, supplying materials for handling as well as nest construction before delivery is a legal requirement that applies to modern breeding systems, but difficulties remain. Issues such as the type and amount of substrates are not clearly defined by the standards (BAXTER et al., 2011).

It is known that the start of nest building is associated with a decline in progesterone and increased plasma concentrations of prolactin and PGF2a. Some behaviors, such as straw collection and trampling have been correlated with changes in prolactin, progesterone and somatostatin, and delivery duration has been shown to be negatively correlated with oxytocin levels (ALGERS; UVNÄS-MOBERG, 2007).

Pre-natal females housed in conventional cells have elevated plasma cortisol levels compared with females housed in enriched breeder pens, demonstrating that containment can be a stressor at this stage (LAWRENCE et al., 1994). Nesting conditions can facilitate birth, making it shorter with positive results for piglet survival. The chances of anoxia in piglets during birth are reduced as is the likelihood of death from other causes (CRONIN et al., 1994).

Compared to females housed in breeders cells without straw, females housed in systems with pens enriched with straw during birth and lactation had shorter deliveries (218 vs. 311 min), shorter times between piglet births (16 vs. 25 min), higher concentrations of oxytocin (77.6 vs. 38.1 pg / ml) and lower concentrations of salivary cortisol (13.2 vs. 19.9 ng / ml). Labor duration is strongly affected by oxytocin levels, and accommodation in enriched bays allows for more opportunities for females to express nest-building behavior, which reduces the duration of labor. Conversely, confined cells with no enrichment materials reduce oxytocin levels during delivery and maintain high levels of cortisol (OLIVIERO et al., 2008). Stress during lactation, which also results from a lack of material handling, increases the percentage of "false breast-feedind" (the array is positioned for breastfeeding, but there is no milk ejection) and the time before the first colostrum intake by the piglets (MANTECA, 2011).

The welfare of the females lodged in breeder cell systems, which is the prevailing business model, is compromised due to physical and behavioral constraints to which the matrix is submitted. This fact has motivated the search for alternatives to conventional breeder cells and the adoption of other models (BAXTER et al., 2011).

## Conclusion

When confining pigs for production, it is essential that environmental enrichment materials

be provided to improve welfare and productivity. Pigs at all production cycles should have access to such materials, which allow them to express exploration and food searching behaviors, while sows have specific nest-building requirements prior to farrow. The routine use of environmental enrichment materials currently poses a challenge to the Brazilian production chain, and compliance must be considered.

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