BALANCING SOW AND PIGLET WELFARE WITH PRODUCTION EFFICIENCY

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ABSTRACT

The close confinement of sows in barren environmental conditions gives rise to major public concern for their welfare. Such concern has resulted in EU legislation to ban individual confinement systems for the majority of gestation, and strong pressures to find alternatives to the farrowing crate for lactating sows. Many alternative loose housing systems for dry sows exist, and have been in widespread use for a number of years. They have the potential to deliver both higher welfare and good reproductive performance, but careful attention to feeding and management to prevent social stress is critical to success. Adoption of alternative non-confinement systems for farrowing and lactation is more problematic. Despite their routine use in some EU countries at the current time, systems which guarantee good piglet survival under large-scale indoor production conditions have yet to be commercially proven. It is likely that changes to both genetics and management will be necessary to make such systems function in an acceptable commercial way.

THE CURRENT STATUS OF SOW WELFARE LEGISLATION IN THE EU

Amongst the many issues in the debate on farm animal welfare, it is those which involve the close confinement of animals in barren environments which have given rise to the greatest public concern. Thus, the keeping of laying hens in battery cages, the raising of veal calves in individual crates and the use of gestation stalls and farrowing crates for sows have been the first targets for campaigns by welfare pressure groups, and the subject of responsive legislation. Within the EU, the first restrictions on sow housing systems were specified in Directive 91/630/EEC, which required the phasing out of tether systems by 2006. Stall systems for gestating sows, while still permitted under this 1991 Directive, were acknowledged to pose a number of challenges to sow welfare and were made a key subject in a detailed review of pig welfare by an EU expert working group (Scientific Veterinary Committee, 1997). As a result of the conclusions from this review, further restrictions were introduced in an amendment to the Directive in 2001 (Directive 2001/88/EC) which requires phasing out of the use of gestation stalls, except for the first 4 weeks of pregnancy, by 2013. Several countries (including Norway, Sweden, Switzerland and UK) have unilaterally implemented a ban on all individual confinement systems for dry sows before this date. The target of animal welfare pressure groups is now the farrowing crate, and the 2001 Directive amendment specifically requested a scientific review of this subject which has recently been delivered (EFSA, 2007). Whilst no EU-wide legislation appears imminent regarding this system, some countries (including Norway, Sweden and Switzerland) have again taken unilateral action to restrict their use, and public pressure in many other countries to find an alternative remains high.

THE WELFARE ISSUES

The welfare aspects which have raised concerns about the close confinement of sows can be divided into physical and behavioural issues. Physical concerns arise from the consequences of lack of exercise for cardiovascular fitness (Marchant et al., 1997) and for bone strength and muscle mass (Marchant and Broom, 1996), potentially giving rise to leg weakness and lameness (Barnett et al., 2001). Lack of activity, in combination with inability to separate the lying and excretory areas, has also been blamed for a higher prevalence of cystitis in confined sows (Madec, 1984). However, whilst these health issues are of importance to producers, it is the behavioural issues which have attracted most attention from the public, with the high level of stereotyped behaviours often seen in confined dry sows providing a highly visual focus for concern. Although initially attributed to the stress of close confinement and the boredom engendered by barren environments, subsequent work clearly demonstrated that the occurrence of these abnormal oral behaviours was much more closely linked to feeding than to housing system (Terlouw et al., 1991). Studies have demonstrated that pregnant sows experience chronic hunger because the level of concentrated feed necessary for maintenance of good health and performance is insufficient to induce feelings of satiety. Expression of the resultant feeding motivation is frustrated in the absence of a foraging substrate, such as soil or bedding, giving rise to channeling of behaviour into stereotype development in restrictive housing conditions. Thus, whilst the housing system is not, in itself, the cause of the abnormal behaviour it is a significant contributory factor to its expression.

For the farrowing sow, the most significant welfare issues associated with confinement again result from the frustration of strongly motivated behaviours by a restrictive environment, although the motivation in question is different. Under natural conditions, the sow seeks a nest site and then builds a nest shortly prior to farrowing in order to provide an appropriate environment to maximize survival of her newborn piglets (Wechsler and Weber, 2007). Such is the importance of this behaviour in an evolutionary context that it has become genetically programmed, and the hormonal state shortly prior to farrowing will induce strong nest building motivation, even when its original function is unnecessary because of human provision of an optimal piglet environment. Prevention of the expression of pre-nesting locomotion and nest building behaviour at this time, through confinement and lack of substrate, results in a measurable heart rate and stress hormone response, in addition to abnormal behaviours, indicating impaired welfare state (Lawrence et al., 1994; Jarvis et al., 2002; Damm et al., 2003). The farrowing crate may also impose other welfare challenges for the sow in later lactation, when she would normally begin the process of gradual weaning by withdrawing from the piglets for increasing periods of time. Enforced proximity and being subject to the demands of increasingly persistent piglets has been associated with elevated levels of cortisol in crated gilts in later lactation (Cronin et al., 1991; Jarvis et al., 2006).

In the case of the farrowing and lactation period, however, the welfare issues do not just relate to the sow. The original reasons for adoption of the farrowing crate were to reduce mortality of neonatal piglets by the control of sow movements which might cause crushing, and by the ability to increase environmental temperature controls and human inputs at a time when these interventions can significantly enhance survival (English and Edwards, 1996). It is the potential for conflict between the welfare needs of the sow and her piglets which has made the issue of the farrowing crate so problematic.

THE NON-CONFINEMENT ALTERNATIVES FOR GESTATING SOWS

For the pregnant sow, a wide variety of alternative systems to the gestation stall exists (Edwards, 1998) and, since the banning or phasing out of confinement systems in many European countries, these have been in use on both small and large commercial scales. In the UK, group housing systems have been operating since well before this became a legal requirement, and a vast deal of practical experience has accumulated. In synthesising advice and information on such systems, a UK advisory body recognised six different generic categories of gestation housing system (Pig Welfare Advisory Group (PWAG), 1997a,b,c,d,e,f,). These can be summarised as follows:

Outdoor Sows

Low capital cost is incurred in a system where dry sows can be stocked at up to 25 animals per ha in large group sizes, contained by double or single strand electric fencing, housed in simple corrugated iron huts, and fed on the ground (PWAG, 1997a). The system is perceived by consumers to be welfare friendly, and is a requirement of some niche marketing schemes. However, unsuitable soil types, extreme climatic conditions and risks of nitrate leaching and pollution limit the widespread applicability of the system.

Yards or Kennels with Floor Feeding

This is the simplest and cheapest of the indoor systems and can be adopted in almost any building. It may be used with small groups and distribution of feed by hand, or large groups with mechanised feed distribution by 'dump' or 'spin' feeders (PWAG, 1997b).

Yards and Individual Feeders

This is generally the most expensive housing system because of the cost and space requirement associated with having a feeding stall for each sow (PWAG, 1997c). However, it provides good welfare safeguards for the sows by allowing precise individual rationing and protected simultaneous feeding.

Cubicles and Free-Access Stalls

This is a cheaper variant in which less space per sow is required, since the stalls serve as both lying and feeding place (PWAG, 1997d). As with individual feeding stall systems, individual rationing can only be achieved by hand feeding unless an additional expensive electronic identification system is added, since it cannot be predicted in advance which sow will enter each of the stalls on a given day.

Yards or Kennels with Short Stall Feeders

Further attempts to reduce cost and space per sow have lead to development of systems in which only head or shoulder length partitions between feeding places are used (PWAG, 1997e). Because of the associated potential problems with bullying and stealing of feed, these are frequently combined with more specialised feeding systems to reduce this risk. Common examples are the ‘Biofix’ or ‘trickle feed’ system, in which feed is metered slowly to each place to prevent inequality of eating speed, and liquid feeding systems in which the greater volume of dilute diet and reduced variability in feeding rate help to minimise problems of aggression.

Electronic Sow Feeders

Large scale automation of dry sow rationing has been made possible by more recent technology which permits individual sows to be electronically identified and allocated a specified amount of diet in a computer controlled feeding station. Economic considerations of utilisation of such an expensive station dictate that this system be used with sequential feeding of individual sows housed in large groups, so that 40-60 sows will typically share each feeding station (PWAG, 1997f).

THE CHALLENGES OF THE ALTERNATIVE GESTATION HOUSING SYSTEMS

The challenges posed by alternatives to confinement systems can relate both to welfare challenges for the animals, and practical and economic challenges for the producer.

Welfare Challenges

The welfare challenges for the group-housed gestating sow relate to social aggression and ability to access a fair share of feed resources. Because of the restricted feed level and chronic hunger experienced by the animals, even on nutritionally adequate diets, competition for feed can be a major source of aggression unless feeding animals are fully segregated. With floor feeding systems, aggression at feeding time can be severe (Brouns and Edwards, 1994; Whittaker et al., 1999) and large variation in body condition can result (Edwards, 1992). In systems with partial feeding stalls (for example, cubicles and free access stalls) significant aggression during feeding can also occur if some sows within the group finish their feed allocations whilst others have food remaining. For this reason, grouping strategies with careful matching of age and body condition are important. Electronic sow feeders require animals to feed sequentially. With good feeding protection and a regular routine, such systems can operate with little aggression. However, any unreliability of the technology due to poor design or maintenance can cause aggression and vice to quickly escalate (Edwards and Riley, 1986). The other source of aggression in group housing systems comes from social instability, since unfamiliar sows will fight to establish relative social rank. The need to operate batch farrowing systems for health control, while maximising sow pen utilisation, means that sows must be mixed at least once in each cycle. However, in systems where very large group sizes are adopted, either to fully utilise electronic sow feeding equipment or to minimise capital cost of buildings, repeated regrouping may be necessary in smaller herds. Such "dynamic grouping" systems carry inherently greater risk of welfare problems arising from social aggression and a high standard of management and stockmanship is necessary if they are to work effectively.

To minimise the problems with social aggression, a number of general recommendations for system design and management, based on scientific understanding of social behaviour, can be made (Edwards, 1992, 2000). Allowing adequate space for social signalling of submissive behaviour, with a minimum of 2.4 m^2 per sow in stable groups (Weng et al., 1998), and providing increased floor area and visual barriers within the pen at the time of mixing (Edwards et al., 1993) can reduce the level and severity of injurious behaviours. Where space is limited to save cost, such as in cubicle and free access stall systems, serious problems of aggression during regrouping of sows can occur and this procedure is best done in other purpose-designed mixing pens prior to introduction. The other key factor affecting aggression, even in the absence of competition for feed, is the level of chronic hunger and frustration of feeding motivation. Different approaches to minimising this risk factor can be adopted (Edwards, 1992). Provision of a foraging substrate such as straw bedding, or even smaller recreational amounts of long or chopped straw, allows appropriate expression of foraging behaviour and has been shown in both experimental studies and practical experience to reduce aggression and lesion scores. In unbedded systems, maintaining animals in better body condition and feeding once, rather than twice, daily to allow greater meal size reduces restlessness and aggression. As an alternative to increasing feed energy allowance, providing increased dietary bulk through fibre incorporation can also induce greater satiety as a result of longer feeding time, greater gastro-intestinal distention and prolonged nutrient delivery and heat generation from hindgut fermentation (Meunier-Salaün et al., 2000).

Economic Challenges

The extent to which acceptable economic performance can be realized in alternative loose housing systems for gestating sows depends on two aspects. The first relates to fixed costs arising from the capital cost of system installation, and the second to the level of reproductive performance which can be achieved in a given system relative to the variable cost requirement. Capital costs of group housing systems for dry sows vary widely depending on the building space requirement and sophistication of feeding system adopted. Total space will be greater than for confinement systems, and initial investment or building conversion cost will therefore be higher unless low cost housing structures can be used, such as deep litter systems in uninsulated buildings or hoop structures. The significant reduction in lower critical temperature of group housed sows in deep litter systems, in comparison to individually housed animals in unbedded systems, can mean that the feed penalty associated with less controlled thermal environments is not always great.

Most producer concerns relate to whether less intensive systems can deliver the same level of reproductive performance as the very controlled conditions of stall housing. Many of the early studies on group housing systems in different countries (for example Denmark and USA) have shown reduced reproductive performance relative to stalls in both conception rate and litter size. However, these studies were often carried out in unbedded accommodation with highly competitive feeding systems and staff unfamiliar with group housing systems. It is certainly the case that social stress on sows at key times in the reproductive cycle will result in suppressed oestrus behaviour, reduced ovulation rate and, most importantly, increased embryo mortality (Arey and Edwards, 1998). Adverse effects of stress have been identified at all levels in the hypothalamo-pituitary-gonadal axis as a result of the influence of changes in a number of hormones and neurotransmitters. Avoiding mixing and social competition around the period of insemination and implantation (7-14 days post insemination) by good housing design and feeding management is therefore key to reproductive success. It is for this reason that most EU countries have retained stalls for the first 4 weeks of pregnancy, although large scale surveys in countries with a tradition of group housing (Arey and Edwards, 1998) and more recent studies in countries in the process of adopting such systems (EFSA, 2007) show that well managed group systems can deliver the same high level of reproductive performance.

Comparisons of performance between different dry sow housing systems using industry survey data have periodically been published, especially at times of transition when different systems are running contemporaneously. In the case of the UK, this occurred during the 1980s and 90s. Such survey comparisons generally, but not always, show lower piglet output in outdoor systems, but show few consistent differences between different indoor systems (Edwards, 2000). Feed use is typically 10-15% higher in outdoor systems, and often reported to be 5-10% higher in floor feeding indoor systems. The extent to which this reflects feed wastage, increased sow activity and/or association with poorer quality buildings is uncertain. In survey comparisons of this nature, statistical information is seldom given and the real significance of apparent differences is often unclear. In general, variation within systems is seen to be much greater than differences between them. Experimental within-farm comparisons of different group housing systems have been carried out within the UK (e.g. Stewart et al., 1993; Broom et al., 1995) and elsewhere within Europe (e.g. Bengtsson et al., 1983; den Hartog et al., 1993). Few consistent performance differences between systems have emerged from such studies but welfare has generally been held to be compromised in group feeding systems, and more at risk in electronic sow feeding systems. Studies have generally focussed on different feeding systems, with confounding of other system components such as group size and/or bedding provision. A further concern has been the reporting of increased culling of sows from group housing systems for lameness and leg injuries incurred during aggression at mixing and mounting behaviour during oestrus, particularly in slatted systems. Once again, correct design of housing and management is the key, with adequate space, non-slippery floors and correct slat and void dimensions.

The recent EU scientific review (EFSA, 2007) therefore concluded that reproductive performance of sows in group housing, even over the breeding period, can be kept at the same level as individually confined sows, and that welfare improvements associated with less restrictive housing need not impair production efficiency.

THE NON-CONFINEMENT ALTERNATIVES FOR FARROWING AND LACTATING SOWS

As with gestation systems, a variety of different approaches to design of non-confinement systems for the farrowing and lactating sow have been tried (Edwards and Fraser, 1997; Weber, 2000). However, relatively few of these have been subject to large scale commercial evaluation. The alternatives can be categorized into three general types:

Individual Housing with Reduced Sow Confinement

Many of these systems have tried to retain the commercially desirable characteristics of the farrowing crate, by making alterations to geometry without substantial increases in space requirements. The 'turn round' crate (McGlone and Blecha, 1987) is a modified design with the side rails flared outward at the back of the crate to allow sows to turn around. The Ottawa crate (Fraser et al., 1988) uses inward-sloping bars to limit the area where the sow can lie and to control the lying movements of the sow, whilst still allowing her space to turn around. An ellipsoid crate design also allows the sow to turn around (Lou and Hurnik, 1994). An alternative approach, which eliminates the crate entirely, is the sloped floor or "hillside" pen (Collins et al., 1987). These pens are comparable in size to a crated pen (1.8 x 1.8 or 2.3m) with a slope of 10-17% on a fully slatted floor and a heated creep area at the base of the slope. In all of these designs, where the sow can turn around but has limited floor space, hygiene considerations dictate the use of fully slatted floors. To accommodate bedding or nest-building material, larger pens are needed to provide separate lying and excretory areas for the sow. Such designs include the "Schmid box" (Schmid, 1993), a 2.5 x 3m pen in which a bedded nest area is separated from an activity area (with feeding and drinking facilities) by a division which contains a heated creep box, the Weribee Farrowing Pen (Cronin et al., 2000) and Swiss designs developed at FAT, Tanikon (Weber, 2000).

Group Farrowing Systems

The much greater space allowance necessary for increased locomotion in the nest site location phase of pre-farrowing behaviour can only be economically encompassed within group housing designs, which also offer possibility of social contact between lactating sows. The most widely used commercial example is the traditional outdoor production system, where a group of sows has unrestricted use of a large paddock with individual farrowing huts. There have been many attempts to replicate this approach indoors under conditions of more restricted space, with a variety of different nest site designs ranging from very simple wooden nests (Fisher, 1990; Algers, 1991), through small square pens with a triangular creep area in one corner (van Putten and van de Burgwal, 1990; Boe, 1993; Goetz and Troxler, 1993; Rudd et al., 1993, Arey, 1994), and walk through crate designs (Rudd et al., 1993, Arey, 1994), to highly sophisticated nest designs such as the Freedom Farrowing system (Baxter, 1991).

Two Stage Systems

A compromise position involves retaining the crate for parturition and early lactation, and then allowing more freedom once the piglets have become established. This can be achieved by systems in which the sow is initially crated, and subsequently given access to a larger pen (for example swing-side crates, Gustafsson, 1982), or by moving the sow and litter from a specialized farrowing facility to a cheaper, "multisuckling" group facility for the rest of lactation (Wattanakul et al., 1997).

THE CHALLENGES OF THE ALTERNATIVE FARROWING AND LACTATION HOUSING SYSTEMS

Once again, the challenges posed by alternatives to confinement systems can relate both to welfare challenges for the animals, and practical and economic challenges for the producer. However, in this instance they have a common factor in the issue of piglet mortality.

Welfare Challenges

Although designed to give welfare improvements in comparison with the farrowing crate, many of the systems still pose some degree of welfare challenge for the sow. In individual pen designs with minimal space, hygiene considerations dictate the use of fully slatted floors and preclude the use of bedding material to provide a nesting substrate. True expression of nest-building motivation is therefore not possible. Whilst research indicates that lack of space is a greater stressor than lack of nesting substrate in the pre-parturient period (Jarvis et al., 2002), this situation is still far from ideal. Even the larger individual pens systems fail to allow enough space for the sow to express the increased locomotion seen in the phase of nest site location. Nor do they allow her to escape the attentions of the litter and reintegrate with the social group as lactation progresses. Group housing systems, which do allow such behaviours, can also have some sow welfare problems. Sows in semi-natural conditions isolate themselves before farrowing and, when penned together, show increased aggression towards other sows as parturition approaches (Arey et al., 1992). If space is restricted, serious bullying can occur.

Economic Challenges

For most alternative lactation systems, capital cost will be increased because of greater space requirement. The exceptions can be the simple group systems outdoors in paddocks or in bedded yards, where costs for building structures can be low in areas where conditions are suitable for such housing. However, the much greater economic issue, and at the same time welfare issue, is the ability of alternative systems to give the same level of pre-weaning piglet survival as the farrowing crate. The performance of the alternative systems in this respect has been reviewed several times in recent years (Edwards and Fraser, 1997; Wechsler and Weber, 2007, EFSA, 2007).

The majority of comparisons of farrowing crate and open pen systems, both in specific experiments and larger scale farm surveys, have shown improved piglet survival where crates were used. Where this was not the case, overall levels of survival were frequently much poorer than currently accepted norms. Whilst data are not always presented, it is important to consider total survival, since misdiagnosis of causes of mortality is common under commercial conditions (Edwards, 2002) and, in many studies, a higher incidence of crushing in non-crate systems is partially offset by a lower incidence of stillborn piglets. Results from other modified crate and individual pen systems have been variable. In many cases, only experimental studies with small sample sizes have been reported. Whilst these have sometimes given promising results, larger scale evaluations carried out subsequently have often failed to sustain high survival levels; for example with the turn round crate and sloped floor crate (Grissom et al., 1990) or Schmid box (Damm et al., 2005). The robustness of systems under commercial conditions, where staff may have less understanding of the requirements to make them work effectively, is an important consideration.

Farrowing systems where sows are kept in groups have often given the worst survival results as a result of failure of a proportion of animals to farrow in the designated nests, disturbance of sows by others during the perinatal period and cases of premature desertion of the litter. Whilst these risks could sometimes be managed under experimental conditions, they proved to be too demanding under commercial conditions. The exception to this has been outdoor farrowing systems, where large scale operations under good management routinely achieve comparable survival levels to those seen in farrowing crate systems, particularly when individual farrowing paddocks are used. The possibility of isolation and minimal disturbance, combined with use of genotypes expressing both better piglet vitality and maternal behaviour, seems to underlie this success. Indoor "multisuckling" systems, which were widespread in the past, but lost favour because of variable performance and difficulty of management, can be economically attractive because of the lower capital cost of such accommodation, but careful management is still necessary if piglet welfare is not to be compromised. Newly grouped litters may experience major disruption of suckling, with an increased frequency of unsuccessful suckling, a high degree of cross-suckling and an increased number of piglets at the udder of individual sows during any suckling attempt (Wattanakul et al., 1997). Hence, piglet growth rate may decrease dramatically during the first few days after grouping, and mortality can be increased.

After many disappointing attempts, however, it does finally appear that non-crate systems might have the potential to deliver acceptable levels of survival under commercial conditions. More recent large scale studies in Switzerland (Weber et al., 2007), Australia (Cronin et al., 2000) and Denmark (EFSA, 2007) have given comparable total survival in crate and pen systems, with greater crushings in pen systems being offset by higher losses from other causes in crate systems. The importance of adequate size of the pens, at least 5 m^2, for the sow to perform appropriate pre-lying behaviours has been highlighted as a critical design feature in achieving this. However, the absolute levels of mortality in these studies still tend to be at the higher end of current commercial norms, and further development and evaluation studies are still required before widespread commercial adoption could be recommended. It is worthy of note however, that Sweden has been operating loose farrowing systems commercially for some years without disastrous consequences.

In summary, whilst non-crate systems for farrowing and lactation now show promise, larger scale commercial comparisons are still required in order to adequately weigh the benefits to sow welfare against possible disadvantages in terms of piglet welfare, cost or practical management.

THE WAY FORWARD

For both gestating and lactating sows, non-confinement systems which can improve sow welfare without unacceptably compromising piglet welfare or production economy do exist. Making these systems an effective commercial reality involves more than just implementing a building design. Although the system is often considered to be the situation into which the sow is placed, factors associated with the sow herself can interact with other components to play a crucial role in system success. Certain genotypes of sow are better adapted to extensive systems, requiring a robust individual, than others. This is particularly apparent in outdoor systems but can also be relevant in indoor group-housing systems. Selection of genotypes for traits more relevant to social and maternal success in non-confinement systems (Baxter et al., 2007; Roehe et al., 2008) will be a critical part of a successful strategy. It is also becoming apparent that the previous physical environment and social experience of the animals can influence later group behaviour (van Putten and Buré, 1997), and understanding and utilising these developmental influences will also be important. Finally, it must be recognised that the system cannot be divorced from the human input of management and stockmanship. Sow observation and management during key production stages such as breeding and farrowing become more critical as artificial aids are reduced.

CONCLUSIONS

Pig producers must consider the long term future of their industry, which ultimately depends on the acceptance of pig production methods by consumers and the wider society. The close confinement of sows in barren environmental conditions gives rise to major public concern for their welfare. Many alternative loose housing systems for dry sows exist, and have been in widespread use for a number of years. They have the potential to deliver both higher welfare and good reproductive performance, but careful attention to feeding and management to prevent social stress is critical to success. Adoption of alternative non-confinement systems for farrowing and lactation is more problematic. Despite their routine use in some EU countries at the current time, systems which guarantee good piglet survival under large-scale indoor production conditions have yet to be commercially proven. However, promising developments are now emerging which, together with appropriate changes in genetics and management offer hope for the future. The extent to which alternatives succeed is likely to depend on the scale of operation, the skill of stockpeople and the philosophy and motivation of the producer. However, such considerations cannot be divorced from production economics. Producers in a very competitive industry can only operate within the bounds of profitability. Initiatives that reduce net margin are not sustainable and any systems which significantly reduce output or increase capital or running costs are only viable if associated with a protected market or reliable product premium.

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