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THE ASSESSMENT OF SOW WELFARE

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The complexity of pig behaviour and the brain mechanisms which control it, is substantial. The learning ability of pigs is considerable and their social behaviour elaborate. As a consequence, welfare problems arise for pigs if they are unable to control events in their environment, if they are frustrated or if they are subjected to unpredictable situations. For example, inability to prevent attack by another pig, to regulate body temperature, or to groom adequately can all lead to poor welfare. Such effects are additional to those which are a result of injury, disease or other pain and physical discomfort.

The welfare status of an animal relates to its attempts to cope with its environment (Broom, 1986, 1988). Poor welfare can result from treatments or situations lasting a few minutes or hours, such as handling, transport, farm operations and slaughter. It can also be a consequence of housing and management systems, as well as physical abuse, neglect and disease. This paper is concerned primarily with the effects of widely used housing systems on dry sows. The effects of handling and transport on welfare are discussed first.

Handling and transport

There is considerable variation in the effects of handling on animals according to how it is carried out and the previous experience of those animals. Rough handling with painful or severely frightening stimuli will lead to substantial responses in all animals. More moderate handling will have little effect on some pigs but will still be very disturbing to others. Hemsworth et al (1981) reported that pigs handled regularly when young were less disturbed when they were older.

The initial response of a pig to a disturbance, such as the close approach of a person or sudden noise, is orientation to the stimulus, suppression of normal activities and preparation for flight, defence or hiding. Behavioural and physiological changes occur together and, in addition to the behavioural changes mentioned above, there is increased heart rate, increased ventilation rate, production of catecholamines from the adrenal medulla, production of glucocorticicoids from the adrenal cortex and associated changes in brain chemistry. All of these can be measured and, by comparison with resting rates, levels during other activities and maximal possible responses, an indication of how hard the animal is having to work in order to cope with the conditions imposed upon it can be obtained. Of particular importance in this assessment is the

time course of the response. An increase in heart rate by a factor of 1.3 for 30s is obviously much less detrimental to the animal than an increase lasting for several hours. Heart rate is a useful measure of the response of animals to various short-term treatments, provided that some account is taken of the ongoing activity (Baldock and Sibly, in press). When fattening pigs were studied by van Putten and Elshof (1978) their basal heart rate was found to be 138 beats per minute. This increased by a factor of 1.5 when an electric prodder was used, by 1.65 when the animals were made to climb a loading ramp and by more if the ramp was very steep (van Putten 1981). Some of this increase is a consequence of the activity; but some is part of the preparation by the animal for emergency responses. A larger increase in heart rate (x 2.6) was found when Augustini and Fischer (1982) studied the effects of driving pigs up a steep ramp and on to a lorry; but animals loaded using a tail-gate lift showed a small decline in heart rate. The heart rate of pigs was elevated much less during transport than during loading in several studies and von Mickwitz (1981) found that the time of feeding prior to loading had the major effect on it.

Behavioural studies of pigs during handling and transport confirm that loading has the biggest effect on welfare. Animals resist attempts to move them, vocalise and adopt defensive postures frequently during loading. Behavioural indicators of poor welfare during the journey are usually associated with inappropriate temperature, high stocking density or poor driving (Jackson, 1973, Augustini et al, 1977, van Putten and Elshof, 1978). Fighting is rare during movement but can cause serious problems when the vehicle is stationary (Pearson and Kilgour, 1980).

Pigs may die during transport and the term Malignant Hyperthermia Syndrome is sometimes used in these circumstances. Sybesma et al (1978) reported on genetic differences affecting the likelihood of death during transport. Pietrain are very vulnerable and Landrace are more vulnerable than Large Whites. Susceptible animals often show a positive response to the halothane test and, in the Dutch study, the death rate was 3.35% for halothane positive pigs, but 0.32% in those which were halothane negative. The quality of meat after slaughter is also affected by the physiological changes associated with high adrenal activity and with the activity associated with fighting. Skin blemishes are also an indication of fighting or bruising due to poor driving. Hence, measurements made after slaughter provide information about the welfare of animals during the journey. Moss (1981) reported that after a two-hour journey from farm to slaughter, 59% of gilts had PSE meat and the mean plasma cortisol level was 6.4g per 100ml. Corticosterone level should also be measured in pigs. If there was a long delay (24 hours) before slaughter, the PSE frequency dropped to 25% in gilts; but 81% of boars had DFD meat. Guise and Penny (in press) have shown that high stocking density and mixing of animals before transport substantially increase the likelihood of carcass skin blemishes. The detrimental effects of mixing on-farm or at loading are of particular interest and the authors recommend that pigs should be kept in their housing groups up to and during transport.

Sow housing

Dry sows and gilts are kept in a variety of systems. These include tethers, stalls, groups with feeding stalls, groups with food supplied on

the floor or in a communal trough, groups with electronic sow feeders, groups in fields or large yards and, experimentally, in the family pen system. There is some variation within each of these categories, particularly with respect to the microclimate, the type of flooring, the use of straw or other bedding materials, the diet and the frequency of feeding. The major variables considered are the types of housing systems and the presence or absence of straw or other bedding. The studies reviewed differ in scientific quality, because of the numbers of observations, the numbers of animals studied, or the involvement of complicating variables, so an attempt is made to evaluate the results accordingly and to emphasise those studies with the most clear cut results.

There is a range of indicators of poor welfare and some information about good welfare can be obtained from studies of what animals choose when given the opportunity. The various welfare indicators will be discussed in turn. It is important to realise, however, that due to individual variation and strain variation in the kinds of coping methods used by pigs, the ideal study combines a range of different measures. Few studies have adequately combined measures so far; but individual measures can give some idea of the minimum numbers of individuals whose welfare is poor in each of several systems.

Growth and piglet production

It is possible that a gilt which fails to grow or a gilt or sow which produces very small litters of piglets may have a welfare problem although other factors contribute. In comparative studies of production systems, however, it is often difficult to discover how many individuals do badly in this way because the data is presented as a mean of all animals involved. Hence, a few pigs which produce well could mask a few bad producers. Where average production figures are used it is clear that well managed units can do equally well whether the sows are confined or in one of the forms of group housing. The quality of stockmanship, an important factor affecting production, will also have an effect on welfare. In general, data on growth and piglet production have not been presented in the agricultural literature in a way which facilitates the identification of individuals with welfare problems.

Reproductive problems

Some sows are culled because they do not become pregnant and others have small litters. These reproductive failures or inadequacies can occur because the sow encounters and has to cope with difficult conditions. Many factors lead to anoestrus in the pig (Meredith, 1982) but several authors have attributed anoestrus to housing conditions. Jensen et al, (1970) reported that tethered gilts reached first oestrus 4 days later than group-housed gilts, Mavrogenis and Robinson (1976) found even larger differences in the time of first oestrus between gilts in stalls and gilts housed in groups. Individual penning of sows can lead to fewer sows becoming pregnant after service, or attempted service, than group-rearing of sows (Fahmy and Dufour, 1976). Sommer (1979), Sommer et al (1982) and Hemsworth, Salden and Hoogerbrugge (1982) also found that stall-housed sows returned to oestrus, after their piglets had been weaned, later than group-housed sows. Maclean (1969), however, reported that in groups where much "bullying" occurred the opposite result was

obtained and veterinary surgeons report that bullied sows can be late coming into heat. This clearly requires further study. Hansen and Vestergaard (1984) also reported that the delay before conception was greater in some group-housed sows. Many farmers with sows in stalls or tethers experience difficulty in getting some of their gilts or sows pregnant; but, in these situations and some of the studies mentioned above, there is doubt about the precise reason. It may be that reproduction is impaired by poor welfare in the housing conditions but assessing such impairment will depend on the stockman's ability to detect signs of oestrus.

The effects of housing conditions on the onset and occurrence of oestrus should be studied in a way which controls all variables, Studies do suggest, however, that there are more problems when gilts or sows are kept in stalls or tethers than when they are kept in a well-managed group-housing system. Welfare can, of course, be poor in group-housing systems where fighting occurs and oestrus is consequently delayed. Other measures of reproductive problems may reflect poor welfare during the gestation period and problems at farrowing. Most studies are complicated by the fact that sow accommodation during both gestation and farrowing may influence the results. Bäckström (1973) compared 1283 sows confined in a crate during pregnancy and farrowing with 654 sows free in a pen at both times. In crate-housed sows there was a higher incidence of mastitis/metritis/agalactia (11.2% : 6.7%) and greater numbers of sows whose farrowing times were longer than 8 hours (5.4% : 2.3%). In more modern systems, however, MMA incidence is considerable less than that found by Bäckström. In a more recent study, Vestergaard and Hansen (1984) studied four groups of sows which were tethered or loose-housed during pregnancy and during farrowing. The duration of farrowing was significantly shorter (mean 234 minutes) in those sows which were loose-housed throughout, than in those which were tethered at one stage or another (mean 335-352 minutes). It seems possible that lack of exercise has some adverse effect on the sow. There was no effect of the sows' housing conditions on the numbers of live piglets born but, since only 70 sows were studied, such a difference would have to have been large to be apparent. Bäckström (1973) and Sommer et al (1972) did find more stillborn piglets if sows were confined.

When all sows in a housing condition are considered, the mean differences between conditions are found to be small but the effect on certain sows is large. There are problems for some sows from group-housing and for rather more sows from confined conditions; but we do not know enough about how this is brought about. On commercial farms which have well managed stall units, reproductive problems are generally thought to be no more frequent than on units with group-housing. It must be emphasised, also, that in surveys such as that of Bäckström, there is a possibility that variation in unit size or in stockmanship may be contributing to the differences reported. In general, the coping systems of animals have evolved to minimise effects on reproductive success, so if there are differences between systems, even a small effect may indicate considerable welfare problems.

Sow disease and injury

Disease can be an indicator that welfare has been poor (Broom 1986,

1988). Animals which utilise their adrenal cortex frequently may have impaired immune system function and greater susceptibility to disease (Kelley 1980, Siegel 1987). The effects of housing conditions on the health of sows and piglets was reviewed by Ekesbo (1981) who pointed out that the relative levels of disease in different systems is much affected by differences in the use of antibiotics.

If sows are exposed to infectious diseases such as Aujeszky's or swine fever, then all may become infected, irrespective of their previous welfare. Non-infectious, or less infectious diseases, such as those leading to some foot and leg problems, sores, torsion of the gut or ulcers, are more obviously related to environmental conditions and the animals' attempts to cope with them. Confined sows appear to be more susceptible than group-housed sows to certain diseases but surveys may well be influenced by other variables. Whilst better studies are needed, several results should be mentioned here. In some cases, disease and injury are difficult to distinguish so these will be treated together.

The effect of housing on farrowing problems has already been discussed. Bäckström (1973) found greater total sow morbidity at farrowing in crate-housed sows (24.1%) than in loose-housed sows (12.8%) as well as greater MMA incidence. The quality of management has improved since these studies were carried out, however. Confined sows may also be more subject to urinary disease and leg problems, whilst group-housed sows are more likely to receive pig inflicted injuries and sometimes have higher parasite loads. Tillon and Madec (1984) noticed that urinary tract disorders had increased in frequency in France during a period when more and more sows were confined. They reported on the relatively high incidence of such disorders in tethered sows and (Madec 1984) suggested that sows might be more prone to urinary disorders if they have to lie on their faeces. They also found that tethered sows drink less and urinate less often than loose-housed sows, so that urine is more concentrated and bacteria have longer to act within the urinary tract (Madec 1985). This problem is probably a consequence of low activity levels and consequent infrequent drinking, hence whilst it could be in part a consequence of the effect of the housing system on the animal, it may be reduced within that system by stockmen encouraging the animals to stand and drink. There is clearly much variation among sows here, as some inactive sows drink infrequently but other active sows drink very often. Tillon and Madec (1984) also reported that in one quarter of tether units more than 20% of sows showed serious lameness. Several other authors have reported similar findings. Bäckström (1973) found that the number of traumatic injuries caused by pen fittings and flooring was 6.1% in confined sows but 0.8% in loose housing. Most studies of leg injuries and infections which cause lameness have related their incidence to the type of flooring. Penny et al (1965) attributed high incidence of foot rot to poor concrete floors and Smith and Robertson (1971) described how poorly designed or maintained slatted floors resulted in many leg and foot injuries and high culling rates. Bäckström (1973) found that 6.3% of 588 sows on partly slatted floors had foot lesions, but these were shown by only 3.3% of 3520 sows on unslatted floors. It is now clear that good slats cause fewer problems than poor slats but the incidence of sow lameness is still very high (Penny 1982). There remains the probability that confinement and associated lack of exercise cause lameness even on good flooring. de Koning (1983) has utilised a precise method for quantifying integumental

lesions and has reported that such lesions can be of high frequency in tethered sow units. It is clear from practical veterinary experience that urinary tract infections and lameness can occur in group-housing as well as in stalls and tethers; but research results suggest that on well managed units with good flooring both problems may be worse amongst confined sows. Further work is required here.

Injuries resulting from attacks by other sows can be serious in group-housing conditions. Good management, for example, a good feeding system and the maintenance of stable groups, can minimise fighting and consequent injury but injury can have a serious detrimental effect on welfare in a poorly managed system. Where sows are attacked by others the lesion can be quantified in a precise way (Gloor and Dolf 1985). Any system for keeping sows which results in high levels of fights which cause injury, vulva biting or tail biting is clearly bad for the welfare of at least some of the pigs. This topic is considered further in relation to behavioural and physiological measures.

Sow activity and responsiveness

Abnormally low levels of activity and lack of responsiveness to events in the surrounding world have been proposed as indicators of poor welfare in pigs (van Putten 1980, Wiepkema et al 1983). Several authors have reported that sows confined in stalls or tethers are inactive for longer periods than are sows in groups (e.g. Ekesbo, Jensen and Hogsved 1978, Jensen 1979, 1980, 1981, Gravas 1982, Carter and English 1983) but others have found no such effect or have reported the reverse (Nygaard et al 1970, Bengtsson, Svendsen and Persson 1983); (see review by Cariolet and Dantzer 1985). Some of these differences are explained by Cariolet and Dantzer's findings that sow activity is affected by parity, stage of pregnancy and extent of lameness. A more important complicating factor is that whilst some confined sows are inactive for much of the time, others show much stereotyped behaviour. If inactivity, with associated unresponsiveness, and stereotyped behaviour are alternative strategies which sows use to try to cope with adverse conditions, the gross measures of the activity of sows in a particular housing condition are not very useful. It is better to study individual animals in detail and to try to assess responsiveness in a precise way. In a series of experimental studies on the responsiveness of sows (Broom 1986b, 1987), stall-housed sows were found to be less responsive to stimuli, other than food presentation, than were group-housed sows. There was, however, considerable variation amongst the stall-housed sows in this respect.

Stereotyped behaviour

Confined sows are not able to groom normally (van Putten 1977), they may have difficulty thermoregulating, most are fed small volumes of food infrequently, they cannot interact normally with other sows and they cannot move away from people or other potentially hazardous stimuli. One response shown by a variety of animals, where the individual has little control of its environment, is stereotyped behaviour (Broom 1983, Dantzer 1986), e.g. bar-biting, manipulating the tether chain or drinker, sham chewing and various other repeated, apparently functionless movements. Such behaviour is occasionally shown by group-housed sows but the mean frequency is extremely low. Examples of reported total duration of

stereotypies in stall-housed sows are: 11% of the 8 hours observed after feeding (Broom and Potter 1984), 10-14% of 24 hours observation time (Blackshaw and McVeigh 1984a,b), and 22% of the time under observation (Jensen 1980, 1981). For tethered sows, examples are: 1.8-28% of 2 hours observation time in different units (Carter and English 1983), 15% of 9 hours of daytime (Bengtsson, Svendsen and Persson 1983) and 14.5-29% of 24 hours (Blackshaw and McVeigh 1984a,b). Some individual tethered sows watched by Cronin and Wiepkema (1984) performed stereotypies for a mean of 80% of daytime observation periods. The figures obtained in such studies depend upon the efficiency of the recording method, especially on the use of videorecording, but there is clearly much variation between sow housing units and within any particular unit, in the amount of stereotyped behaviour shown. Gilts show less stereotypy (Blackshaw and McVeigh 1984a,b, Cronin and Wiepkema 1984), and such behaviour is not evenly distributed through the day (Rushen 1984, Broom and Potter 1984). Many reports from farmers of low incidence of stereotypy, however, are a result of failure to notice some stereotypies, such as sham chewing, and there may be some reduction in the incidence of stereotypies when human observers are present.

Diet can have an effect on stereotypies. If added roughage is in the form of a manipulable material such as unchopped straw, there can be considerable reduction in stereotyped behaviour but chopped straw does not have this effect (Fraser 1975). The addition of high bulk material to concentrates caused a redistribution of stereotypies but no net change in total duration in one study (Broom and Potter 1984). A high level of feeding (4kg per gilt per day) resulted in much lower levels of stereotypies than a low level (1.25kg per gilt per day) in a study by Appleby and Lawrence (1987). It seems from these results that a combination of feeding at maintenance level, or less than maintenance level, combined with confinement, results in a high incidence of the very active stereotyped behaviour response. More work is needed to ascertain which coping methods are used by which individual pigs in the various kinds of difficult conditions which sows encounter.

There is much debate about whether stereotypies are a method used by animals to help them to cope with adversity or a pathological consequence of trying to cope but, whatever the results of this debate, there is no doubt that an animal showing stereotypies for a long period is very abnormal in its behaviour. The stereotypies are an indicator of poor welfare and they are frequent in most sow stall and tether units. The relatively low levels at which pregnant sows are commonly fed may be a contributory factor to poor welfare but the confinement itself must be a major part of the problem for the animal.

Aggressive and other injurious behaviour

The welfare of an animal which is injured by another, or which is often pursued by another, or whose movements are severely restricted by the presence of other dominant individuals, is probably poor. Aggression does occur in tethers and stalls but whilst its frequency may be high (Vestergaard and Hansen 1984, Barnett et al 1987, Dolf, in press) the physical effects on the individual attacked are slight. Some farmers using group housing systems for sows report serious fighting and extensive wounding. The extent of this fighting is greatest if there is

competition for food. The system studied by Csermely and Wood-Gush (1986), which would be regarded generally as a poor one, was a group of 11 sows whose food was dropped automatically on to the floor from above. Most agonistic encounters occurred within 30 minutes of the food drop. The group was stable and no serious injuries resulted from the fighting but the welfare of subordinate sows is probably very poor and Csermely and Wood-Gush recommended that visual barriers should separate sows at feeding places. A group-housing system with well designed individual feeding stalls allows all sows to feed at once with no aggression being possible during feeding. This would seem to be a good system on welfare grounds. A modern version of this system and the electronic sow feeder system are described by Edwards (1985). The electronic sow-feeder system (see also Lambert, Ellis and Rowlinson 1983) has the advantage that sows receive their own individual ration but the disadvantage that only one sow can feed at a time, so sows tend to queue for feeder access. Early versions of electronic sow-feeder systems had disadvantages which lead to considerable problems of bitten vulvas and other injuries. These included poor design and positioning of the feed crate, e.g. a back gate which did not prevent contact by sows behind, a rear exit only system, a gate which allowed other sows to follow the first in, or a feeder positioned in a lying area. Work on management and studies of behaviour (Lambert et al 1983, Lambert, Ellis and Rowlinson 1984, 1985, 1986, Edwards 1985, Hunter et al 1988) in electronic sow feeder systems have shown that efficient training, a sufficient number of feeders, once a day feeding, stable grouping, front exit feeders and a good bedded lying area or kennel can result in few welfare problems. It will probably not be possible to remove all problems, for example sows may prefer to feed in groups but only one sow at a time can feed on this system. A disadvantage of this system is that it is a little more difficult for the stockman to operate and more careful observation of sows is required in order to avoid problems. A further problem is that welfare can be very poor if the electronic equipment breaks down.

Another group-housing system, in which boars and offspring are present with the sows, is the family pen system developed by Stolba and Wood-Gush (Stolba 1982, Wood-Gush 1983). The sows have a more diverse and interesting environment in this system and there are seldom any indicators of welfare problems. Even more is demanded of the stockman running this system, however, so there might be risks to welfare if an inefficient stockman was involved.

Adrenal and other physiological measures

Measurements of plasma glucocorticoid levels are useful indicators of the welfare of animals subjected to short-term procedures such as handling and transport. Single blood samples, however, like measurement of heart rate, are of little use when the long-term effects of housing systems are being evaluated. The evaluation of responses to a challenging situation after various previous housing conditions is of some interest, although precise interpretation is rather difficult. Barnett et al (1984) compared the cortisol responses to loading and transport and to ACTH challenge in sows previously kept in tethers, pairs or groups. The tethered sows showed a greater response to the transport and some sign of a higher response to ACTH challenge but there were also high responses from some animals in pairs. Barnett et al (1981) had found that tethered

sows had higher plasma cortisol levels than stall-housed sows and a further study (Barnett et al 1987) showed that this higher level could be reduced by using wire mesh between the tether stalls. These results may not, however, reflect long term responses to the housing conditions.

The possibility that animals may cope with prolonged exposure to difficult environments by self narcotisation using naturally occurring opioid peptides such as endorphin has been proposed. Studies on pigs are limited to the finding that stress-induced analgesia is apparently non-opioid in pigs (Dantzer, Bluthe and Tazi 1986) and to the work of Cronin, Wiepkema and van Ree (1985) on the link between stereotypies and opioid peptides. Cronin's experiment demonstrated, by the use of the receptor blocker naloxone, that the behaviour and the inhibitor are linked in some way. It may be that sows use stereotypies as a means of self narcotising but this is by no means proven. It is also possible that other behavioural indicators of poor welfare, such as lack of responsiveness, are associated with self narcotisation but at present we have no clear indicator of the use of such methods of coping.

Studies of preferences and the improvement of welfare

In designing their family pen system, Stolba and Wood-Gush utilised information from their studies of how sows preferred to spend their time in an extensive and varied outdoor environment (Wood-Gush 1983). Such studies are of value when designing systems which can then be compared on welfare production grounds with existing systems. Simpler preference studies also aid in the development of systems in which welfare may be improved. Sows in fields spend much time rooting so Wood-Gush and Beilharz (1983) assessed the usage of earth by pigs in bare environments. These pigs used the earth a lot and Hutson (personal communication) has found that pigs will carry out operant responses many times where the opportunity to root in earth is the reinforcer. Studies of the floor preferences of gilts have been carried out by van Rooijen (1980, 1981, 1982). In studies where floor preference was balanced against social attraction van Rooijen was able to demonstrate that earth floors were much preferred to concrete but that the preference for straw over woodchips was less clear cut. The extensive usage of straw as a material to manipulate is clear from many studies on sows e.g. Jensen (1979) and Bengtsson, Svendsen and Persson (1983). Fraser (1975) described how the provision of long straw lead to a clear reduction in the duration of stereotypies in stall-housed sows and many research studies have suggested that straw is desirable as a material for bedding and for manipulation by sows and fattening pigs (Jongebreur 1983, Gloor and Leimbacher 1984, Grauvogl 1987). Straw may not be the only material which serves this purpose and its beneficial effects may not counteract all the effects of an otherwise adverse environment but is use should be considered in all systems where no comparable material is present.

SUMMARY

The assessment of welfare involves different measurements according to whether the difficulty encountered by the animal is short-term or long-term. Useful measures of the effects of handling and transport on pigs include various behavioural responses, heart rate, glucocorticoid levels in body fluids, brain chemistry, meat quality, carcass skin blemishes and mortality rate. Indicators of poor welfare in sows include growth and piglet production; reproductive problems; disease and injury incidence; activity and responsiveness; stereotyped behaviour; injurious behaviour; adrenal activity and opiate peptide production and action in the brain. A combination of measures is needed, if poor welfare is to be identified adequately, as there is individual variation amongst sows in their response to difficult conditions. Studies of animal preferences are also of value if the importance of the preference to the animal is assessed.

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