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The welfare of low-volume farm animals during transport and at slaughter: a review of current knowledge and recommendations for future research

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Abstract

Meat from low-volume farm animals such as farmed deer and wild boar is currently widely available to the consumer within the UK. Despite a rapid growth in production of these species there is a paucity of research that focuses on their welfare. This paper reviews the current literature and legislation relating to the transport and slaughter of farmed deer, wild boar, ostriches, buffalo and bison in order to identify priorities for future research. Research on low-volume farm animals has focused on red deer and their welfare is safeguarded with comprehensive legislation and guidelines. Studies have indicated the importance of appropriately designed facilities and sympathetic handling of red deer to ensure humane slaughter with minimal stress. However, the impact of transport and slaughter on the welfare of other deer species has not been recorded and this should be recognised. Much research has been conducted on the welfare of ostriches during transport and at slaughter. However, many of the results are discordant and research is required to clarify, in particular, posture during transport and stunning methods. Research on the welfare of wild boar, buffalo and bison is scarce. Best practice for both transport and slaughter of these species needs further research and clarification within legislation. For the low-volume species discussed in this review, priorities for further research include (1) appropriate methods of handling to minimise stress during transport and slaughter; (2) identification/clarification of appropriate slaughter methods and (3) training of transport and abattoir personnel in handling and slaughter methods.

Keywords: *animal welfare, buffalo, bison, deer, ostrich, slaughter, transport, wild boar*

Introduction

Despite a growth in the production of non-traditional farm animals, such as deer (*Cervus elaphus*), wild boar (*Sus scrofa*), ostrich (*Struthio camelus*), buffalo (*Bubalus arni*) and bison (*Bison bison bison*), and the associated advances in knowledge and farming experience there is limited research literature concerning these 'low-volume' species. In particular, there are few studies (with the possible exception of red deer) on their specific welfare needs during transport and slaughter. However, it is clear that inter-species behavioural and physiological differences result in the need for different handling strategies to minimise welfare problems during these practices compared to traditionally produced species. Therefore, to ensure high levels of animal welfare it is important that these differences are identified and that clear guidelines are produced that can be followed by producers, hauliers and abattoir personnel involved in the management of low-volume farm animals.

Animal transport and slaughter legislation

There is little information for producers in terms of legislation and codes of practice relating to low-volume production animals. Current domestic legislation for the welfare of animals during transport is documented in The Welfare of Animals (Transport) Order 1997, based on European animal welfare rules. New EU rules on animal welfare during transport will come into force in 2007. This new legislation aims to improve animal welfare during transport by designing and maintaining vehicles with animal welfare in mind and by ensuring animals are handled by trained, sympathetic personnel (Department for Environment, Food and Rural Affairs [Defra] 2005).

Current animal slaughter legislation is set out in The Welfare of Animals (Slaughter or Killing) Regulations 1995 but the specific needs of the non-traditional species discussed in this review are not covered by these regulations. However, guidelines have been drawn up by various organisations, including most recently the report 'The Welfare of Farmed Animals at Slaughter' (Farm Animal Welfare Council [FAWC] 2003) which makes specific reference to the acceptable slaughter of deer, wild boar and ostriches and suggests limited recommendations for minimising stress and maximising welfare. There are further guidelines for deer welfare in the 'Code of Recommendations for the Welfare of Livestock: Farmed Deer' (Ministry of Agriculture, Fisheries and Food [MAFF] 1989) and the 'Code of Welfare Practice on Abattoir

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Slaughter of Farmed Deer' (MAFF 1988). Defra have also published non-statutory guidance on the slaughter of ostriches, listing statutory welfare requirements and major ostrich slaughter issues (Defra 2003). All licensed slaughter houses are supervised by official veterinary surgeons on behalf of the Meat Hygiene Service, a Government Agency and part of the Food Standards Agency (Defra 2004). Licensed abattoirs in Great Britain have declined in number from 767 in 1990 to 367 in 2002 (FAWC 2003). Although the number of traditional species slaughtered has decreased from 316 million animals in 1983 to 26.3 million in 2002, the number of non-traditional animals slaughtered has increased. In 2002 83935 deer, 3024 ostriches and 1292 wild boar passed through UK abattoirs (FAWC 2003). This factor, along with fewer abattoirs, adherence to meat hygiene regulatory requirements and compliance with retailer-approved abattoirs, has contributed to increased travelling distances to slaughter and associated welfare implications (FAWC 2003).

Welfare implications of transport and slaughter

Welfare problems associated with the transport of traditional farm animals are well documented and a review can be found in Broom (2000). Scientific measures of welfare at transport include the measurement of injuries, bruises, mortality, morbidity and carcass quality, along with behavioural and physiological measures. Behavioural measures during handling for transportation include the frequency of stopping, freezing and backing-off incidents, with different levels of effect of handling shown between species. Broom (2000) summarises that "Sheep are not greatly affected, cattle are sometimes affected, pigs are always affected and poultry which are handled by humans are always severely affected" (Broom 2000 p 46). These species differences also exist in the capacity of animals to adapt to transport demands (Adams 1994). It is probable that other species, such as deer and wild boar, will also show differentiation in their tolerance of handling and transportation.

As with handling for transportation, it is well documented that handling at slaughter has an influence on the animal's welfare. Inappropriate handling prior to slaughter has been shown to lead to detrimental effects on meat quality in traditional farm animals (Voisinet *et al* 1997; van der Wal 1997; Faucitano 1998; Meisinger 1999) and cortisol levels have been found to increase with poorly designed lairage facilities (see Grandin 2000 for a review). The use of the correct stunning and sticking methods, and short stun to stick intervals are also important in ensuring good welfare (Anil *et al* 1995; Anil *et al* 2000). Suitable slaughter practices for traditional farm livestock are well established. However, there is little evidence that these types of practices are appropriate for other types of livestock. Therefore, there is a need for underpinning knowledge of slaughter requirements for low-volume farmed species.

This paper reviews current literature on the welfare during transport and at slaughter of deer, wild boar, ostrich, buffalo and bison produced within the UK meat industry. It aims to identify gaps in knowledge and specific areas of concern relating to the welfare of low-volume farm animals, and make recommendations for future research and training.

Deer

Census data (MAFF 1998) estimated that 240 farms included farming deer as part of their agricultural enterprise, although this figure only includes England and Wales and does not include holdings with park deer. More recently, unpublished sources from the British Deer Farmers' Association, which represents approximately 60% of UK farms with deer, have estimated the UK figure to be 316 holdings with farmed deer. MAFF (1998) reported that the national herd totalled around 24 thousand animals at that time, of which 77% were red deer, 22% fallow deer and 1% all other deer. The majority of the research on deer has, perhaps as a consequence, been conducted on red deer. Generally, it is thought that deer may be more susceptible to stress-related diseases than more traditional livestock, on account of their adaptation to farming through taming rather than through domestication (Hemmer 1990; Hanlon *et al* 1995).

Transport of deer

More comprehensive research has been carried out on the impact of transport and slaughter practices on deer than any of the other species discussed in this review. The body of research on transport practices suggests that many of the concepts for successful movement of deer are already embodied in general current legislation with further guidance provided in the Deer Welfare Code (MAFF 1989). Deer in the UK are transported in a variety of transporters. A survey of 60 deer farmers in the UK found that 48% of farmers transport their animals in single-deck livestock wagons, 19% in double-deck livestock wagons and 32% in stock trailers (Bornett *et al* 2004).

Several studies have suggested that transport can be stressful to deer. Smith and Dobson (1990) reported that red deer transported to an abattoir had higher average cortisol concentrations (> 20 ng ml^{-1}) and muscle pH (> 5.74) than deer shot in the field (< 7 ng ml^{-1}, pH < 5.74), although only four of 66 male deer transported to the abattoir had a muscle pH above 6, the threshold pH associated with dark cutting meat in red deer. Although these responses tend be short term (Grigor *et al* 1997) and individuals recover to baseline levels after unloading (Grigor *et al* 1998a), there is no evidence for habituation to stress following repeated transport events (Waas *et al* 1999).

The stage of pre-transport handling that has the most likely welfare implication is loading. Grigor *et al* (1998c) noted the aversiveness of loading to deer and suggested that the width of the loading race may affect the ease of loading (Grigor *et al* 1998d). The same authors also looked at the shape of the ramp, using a straight or curved design, and illumination of the ramp, either bright or dim, but neither of these factors affected the time taken to enter the trailer (Grigor *et al* 1998d). To ease loading, Smith and Dobson

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(1990) recommended that the loading ramp should be shallow-angled in preference to a steep gradient.

The journey itself has received some attention by researchers and several factors have been assessed, including journey length, road type and vehicular motion, and how the animals are grouped within the vehicle. The effects of journey duration on welfare have been researched with varied conclusions. Waas *et al* (1997) reported a twofold increase in cortisol during a two hour trip of red deer stags and later a threefold increase (Waas *et al* 1999), suggesting that stress increases linearly with journey length and should therefore be minimised to avoid welfare problems. However, Grigor *et al* (1998a) looked at behavioural and physiological reactions of farmed red deer to transport and concluded that, although there was evidence for at least a partial adaptation to the stress of transportation as journey time increased, transport of up to six hours produced both physical (increased heart rate and weight loss) and psychological (increased concentrations of plasma cortisol and non-esterified fatty acids) signs of stress for deer. Behavioural signs suggested that the journey was stressful, especially during the first hour. This was seen in the form of the animals being more alert and spending more time standing, and less time lying and ruminating (Grigor *et al* 1998a; Grigor *et al* 1998d). As with physiological measures, behavioural indicators appeared to return to those of pre-transport levels within the second hour of the journey (Grigor *et al* 1998d). Grigor *et al* (1998b) also found that after transportation red deer were more reluctant to enter a raceway compared to those not transported. This indicates that transportation may aversely influence the animals' handleability when they arrive at lairage.

The effect of the lie of the road travelled along has been reported to have welfare and economic implications. Jago *et al* (1997) found that road type influenced behaviour during transport, with steep, winding roads and the start of journeys leading to increased loss of balance and impacts but that increasing the distance travelled (80–380 km) had no significant additional effect on these behaviours. In an earlier study, however, bruising was found to vary significantly with distance transported and carrier-company and the importance of careful driving was noted (Jago *et al* 1996).

Position within the vehicle has been found to have a significant effect on the heart rate of red deer, with higher values being found towards the rear of the vehicle (Waas *et al* 1997). Those authors proposed that this might be as a result of the increased horizontal and vertical motion experienced at the rear, especially on rough and winding roads, and that therefore red deer should be loaded towards the front of vehicles if possible. Red deer have also been found to prefer to stand perpendicular or parallel to the direction of travel and it is suggested that deer choose this either because they prefer to be in contact with a wall or that it is a way of coping with the movement of the vehicle (Grigor *et al* 1998a).

As with the grouping of animals for any other purpose, stress can be reduced by transporting groups of animals that are of a similar order of weight and have some social familiarity (Jago *et al* 1997) and by ensuring that the animals are not in any sensitive phase of their life cycle, particularly the oestrous periods of their reproductive cycle (Jago *et al* 1996; Waas *et al* 1999). Jago *et al* (1996) also recognised the importance of not transporting males during the rut. Increasing the stocking density of red deer in transit has been shown to significantly increase physiological responses indicating stress, albeit that the increases are small, in comparison with, for example, handling in a crush (Waas *et al* 1997). Those authors recommended a maximum density of 0.40 m^2 per 100 kg animal. Grigor *et al* (1998a) found that stocking at high space allowances, ie low stocking densities (0.8 m^2 per female deer; 1 m^2 per male deer), increased the number of times that red deer lost their balance. However, they did note that on no occasion were deer observed to fall during transit.

Research on the effects of transport on 'wilder' deer that are not regularly housed and used to human contact, and the impact on the welfare of deer species other than red deer during transport is not recorded and this gap in understanding should be recognised.

Slaughter of deer

Current slaughter options for deer are: field shooting, transport to a multi-species abattoir or specialist deer abattoir, or an on-farm slaughter facility. Whilst farmers may prefer the idea of field slaughter, and this method provides the lowest values for physiological stress indicators (Smith & Dobson 1990; Pollard *et al* 2002), lower hygiene standards, legislative constraints, cost-effectiveness and a preference not to see personally reared animals killed on farm are all factors affecting slaughter choice (Emerson 2003). The welfare at slaughter legislation is not written specifically with deer in mind and the FAWC report (2003) concluded this should be addressed where necessary to protect deer. Three recommendations were made by FAWC (2003).

1) Government should provide guidance on the killing of deer in the field. There is currently debate over how many deer can be shot in one field slaughter session before the rest of the herd become agitated.

2) Facilities used for lairaging and restraining deer, wherever they are killed, should be specifically designed for the purpose.

3) Deer should be stunned within a drop-floor crate to enable them to be firmly but calmly restrained.

The MAFF Deer Welfare Code (1989) reported that humane slaughter of tame or semi-wild deer up to a 40 m range can be achieved by accurate shooting using a suitable rifle and ammunition, with suggestions of being able to shoot up to ten deer from a large, quiet group before unduly stressing the others; at greater distances, shooting should only be attempted by proven marksmen in exceptional circumstances. Suitable rifles and ammunition are firearms that

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comply with the amended Deer Act 1963 (England and Wales) or the Deer (Scotland) Act 1959 and the Firearms Act 1968.

Lairage facilities and duration at lairage have been shown to be important in a number of studies. Bruising of red deer at an abattoir was related to duration of lairage for some periods of the year, with least in the spring and most during the summer (Jago *et al* 1996). Studies which looked at effects on inquisitive, locomotor, aggressive and abnormal behaviour of deer have indicated that welfare may be improved by darkening holding areas (Pollard & Littlejohn 1994), increasing pen size (Pollard & Littlejohn 1996) and reducing proximity of penned deer to other species, taking into account specific interspecies aversion and previous exposure of the deer to other species. Specifically, red deer were more averse to pigs than to cattle, and red deer with previous exposure to cattle were more averse to cattle than deer without prior exposure (Abeyesinghe *et al* 1997; Abeyesinghe & Goddard 1998). Welfare could also be improved by reducing the mixing of red deer with unfamiliar groups of conspecifics during lairage. Hanlon *et al* (1995) reported that, compared to deer kept in stable groups, deer that were mixed into unfamiliar groups every four weeks exhibited higher levels of aggression and had larger increases in cortisol levels in response to challenge with ACTH. If mixing is unavoidable then the provision of a cover within a holding pen may reduce aggressive behaviour and thus improve welfare (Whittington & Chamove 1995; Hodgetts *et al* 2002).

A number of studies have indicated the aversiveness of deer to physical restraint, using latency to enter and time to move along a race (Grigor *et al* 1998b); proximity to a human, both stationary and approaching the animal (Pollard *et al* 1994); and physiological parameters, including cortisol and lactate (Pollard *et al* 2002). Carragher *et al* (1997) compared the relative stressfulness of different yarding and handling procedures. The treatments were: (1) yarding a group into a pen, (2) giving additional handling in the pen and (3) restraining in a crush for 2 min. Each of the treatments resulted in elevated physiological blood parameters and increased heart rates. The increases were greatest in those animals in the crush treatment, although these increases were only short-lived. Additionally, they reported that the animals that had been handled in the crush took 20–40 min longer to return to grazing than the other two groups.

As with findings for stress-related parameters during transport (Smith & Dobson 1990), there is evidence that physiological stress indicators are raised during pre-slaughter handling procedures. In an attempt to identify the most influential stages of pre-slaughter handling on welfare (on-farm, in-transit, at the abattoir), physiological monitoring by Waas *et al* (1999), using levels of haematocrit, lactate and heart rate sampled remotely, indicated that red deer may find events such as initial herding/penning and loading/unloading, where handling is more intense, more aversive than other parts of the transportation process, such as on-road transport itself.

The effects of pre-slaughter handling on meat quality may only be minor (Pollard *et al* 2002) and so the compulsion to encourage less stressful handling during pre-slaughter, on the grounds of reducing the value of the meat product, may not be demonstrable.

These studies indicate the importance of appropriately designed facilities and informed, sympathetic handling to ensure successful humane slaughter with minimal stress.

Wild boar

There are approximately 100 UK wild boar farms and demand for wild boar is currently higher than supply (Taylor 2004). Around 40 farms are members of the British Wild Boar Association (BWBA) accounting for approximately 80% of British farmed wild boar (Taylor 2004). The BWBA estimates that the UK wild boar market is worth £2 million with the annual market for stock valued at £100 000 (Taylor 2004). However, although wild boar farming is increasingly popular, there is little scientific literature on the behaviour of captive wild boar.

Transport of wild boar

A small survey of wild boar farmers (Bornett *et al* 2004) indicated that 75% of wild boar are transported in unmodified stock trailers, in a similar way to domestic pigs. There are no published studies on the welfare of wild boar during transport. Domestic pig welfare issues have been more comprehensively studied, including transport time effects (Dalin *et al* 1993), loading stress (Bradshaw *et al* 1996), lairage time (Warriss *et al* 1998), stocking densities (Gade & Christensen 1998) and mixing (Bradshaw *et al* 1996). However, wild boar differ in both appearance and physical ability in comparison to domestic pigs, and research comparing wild boar and domestic pig behaviour is limited. Similarities have been reported in the foraging (Gustafsson *et al* 1999a) and maternal behaviour (Gustafsson *et al* 1999b) of crossbred (wild boar/domestic) and domestic pigs. However, Robert *et al* (1987) found that European wild boar were more active than domestic pigs. This could be due, in part, to their anatomical differences. Therefore, although behaviourally similar to domestic pigs, the impact of these physical differences on practical management and welfare requirements during transport and slaughter requires significant further study.

Slaughter of wild boar

At present, wild boar can either be field slaughtered, sent to a multi-species abattoir or transported to a specialist slaughter facility. In 2002, 1292 wild boar were slaughtered at licensed abattoirs (FAWC 2003). However, there are currently only 23 abattoirs licensed to slaughter wild boar and the geographical location of wild boar farms bears little relationship to abattoir distribution, particularly in South East and Northern England (Taylor 2004). This inevitably means long transit times for some wild boar. Proximity to a licensed wild boar abattoir is an important factor for new

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entrant farmers and a deterrent to some faced with unacceptable distances (Taylor 2004).

The Welfare of Animals (Slaughter or Killing) Regulations 1995 legislation makes no specific mention of the slaughter of wild boar. After observing wild boar slaughter in a small multi-species abattoir, the FAWC Report (2003) suggested the following:

- Wild boar should ideally be unloaded immediately on arrival.
- They should be held in familiar groups.
- High-sided unloading and lairage facilities with a clear route to the killing pen for ease of movement should exist.
- Lairage and restraining facilities even in multi-species abattoirs should be specific to wild boar and must prevent wild boar escape.
- Individual wild boars should be separated into the killing pen using standard pig boards although this is recognised to be a dangerous procedure for the handler.
- Animals being shot should be confined in the killing pen and left to quieten down before a shot is taken.
- Slaughter personnel should be expert marksmen, as should field marksmen.
- The use of a shotgun, although noisy, was the best slaughter method observed; electric tongs stunning was considered stressful for animals and hazardous for slaughter personnel, although noted as being preferred by some.

Best practice for both transport and slaughter of wild boar, whether field or abattoir slaughter, is still subject to debate and needs further research and clarification within legislation.

Ostriches

Ostriches were first introduced into the UK in the late 1980s (British Domesticated Ostrich Association 2006) and in 2001 there were 4769 licensed ostriches in England and Wales (Greenwood *et al* 2001) that produced meat, eggs and feathers. Due to their size and strength ostriches require specialist handling skills and must be licensed under the Dangerous Wild Animals Act of 1976. They are also known to be susceptible to stress (Adams & Revell 1998).

Although there is no specific legislation that covers ostrich welfare, several sets of guidelines and recommendations have been produced. In 1994, MAFF issued guidelines prepared by the FAWC regarding the welfare of ostriches on farms, based on limited knowledge at the time. Following this in 1997, the Council of Europe wrote a set of recommendations under the Standing Committee of the European Convention for the Protection of Animals Kept for Farming Purposes, highlighting the requirements for the training of handlers and minimum transport to slaughter times (Adams & Revell 1998).

Transport of ostriches

Ostriches may be transported at regular intervals throughout their lives: as day-old chicks, 3-month-old chicks, yearlings (slaughter weight) and 2–2.5-year-olds (sexually mature). Specialist transport is required for each group (Wotton & Hewitt 1999). Ostriches tend to be transported on a number of vehicle types, with modified cattle transporters often being employed. They are often transported by air and road over varying distances (Mitchell 1999). Although there is no specific legislation regarding the transport of ostriches they are covered by The Welfare of Animals (Transport) Order 1997. One particularly relevant requirement is that on a journey over 50 km, there should be at least one person with specific training or equivalent practical handling experience on the vehicle (Wotton & Hewitt 1999).

A study by Mitchell *et al* (1996) reported that 10-month-old ostriches suffered substantial stress during a 4.5 h journey in a commercial vehicle as indicated by a 75% rise in plasma corticosterone. They also reported a 2.6-fold increase in plasma uric acid accompanied by a 16% rise in plasma protein consistent with extracellular fluid shifts or a degree of dehydration. They suggested that dehydration could be exacerbated by polypnea observed in ostriches during transport. Behavioural changes that may be indicative of stress also occur during transport. Ostriches have been observed head bobbing, neck arching (Mitchell & Kettlewell, unpublished data 1996), blinking very slowly, neck-twisting and jumping (Payne 1993) whilst being transported.

Crowther *et al* (2001) categorised stressors during transport as either irritant (eg continuous noise, vibration, heat exposure, crowding) or intermittent stressors (eg sudden flashes of light, noise from passing vehicles). They suggested that irritant stressors have a compounding effect, which over a period of time may cause unacceptable levels of stress in the birds, and that future research should be focused on these stressors.

Vibration and movement during transport can cause loss of balance which can result in injury and trampling by other birds. 'Capture myopathy' (exertional rhabdomyolysis which can result in paralysis and death) normally occurs as a result of prolonged physical exertion but has been reported in ostriches during transportation in New Zealand where journey times often last 10–15 h (Crowther *et al* 2003). To prevent injury and illness caused by loss of balance, Wotton and Hewitt (1999) suggested that ostriches should be transported in small groups and given enough room to sit down. Crowther *et al* (2003) reported that sitting behaviour is associated with a drop in heart rate suggesting that allowing ostriches to sit could have a calming effect during transportation. Ostriches normally sit down at dusk and therefore ostriches can be further encouraged to sit down by reducing light levels on the transporter or transporting ostriches at night (Crowther *et al* 2003). However, there are concerns that ostriches sitting down during transport are more likely to be trampled on by other birds and may be killed by suffocation or neck dislocation (Wotton & Sparrey 2002). Thus, further investigation into ostrich posture during transport is required.

Heat stress and dehydration have also been reported as a problem during transport (Adams & Revell 1998; Crowther

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et al 2003). The source of heat is the radiation from the animals themselves as well as conduction of heat from outside. It has been found that ostriches refuse to drink during transportation and dehydration has been demonstrated by the excretion of thick, white, concentrated urine immediately after transportation (Crowther *et al* 2003). A behavioural indication of heat stress during transport is that of 'gular pumping'. This is a physical mechanism of lowering the tongue to increase the intermandibular air volume and therefore increasing body water evaporation (Payne 1993). Adams and Revell (1998) suggested that refrigerated lorries kept at 10–15°C be used to transport the birds to reduce the risk of heat stress and dehydration. In addition, birds should be well nourished and fully hydrated before departure. It has been suggested that farmers should check the excretions of the birds that are to be transported to check for signs of dehydration and correct as necessary (Mitchell 1999).

Mitchell (1999) suggested the following guidelines for transporters:

- Vehicles should have closed sides.
- There should be adequate ventilation.
- Light levels should be kept low.
- Space allowance should be at least 0.75 m^2 per adult bird.
- Birds should be allowed to stand or sit as they wish.

There is also evidence in the literature that it may be beneficial for ostriches to be transported with familiar individuals or be given visual contact with familiar animals (Payne 1993). This may prevent some of the seeking behaviour such as jumping and head bobbing that occurs during the transportation of ostriches.

Loading and unloading from the vehicle are also reported to be stressful to ostriches. Wotton and Hewitt (1999) suggested that birds should be loaded using ramps at the minimum angle. Mitchell (1999) suggested that this angle should be no greater than 25° and that ramps should be covered with a non-slip mat. In their guidance on the slaughter of ostriches, Defra (2003a) recommended that, in addition to non-slip flooring, horizontal surfaces should be provided with solid sides or barriers to a height of two metres for unloading. In addition, Charnley (1999) recommended that ostriches be hooded during loading as it prevents them from over-reacting to sudden movements.

Slaughter of ostriches

The welfare of ostriches at slaughter is protected under the Welfare of Animals (Slaughter or Killing) Regulations 1995. However, these regulations do not give any specific recommendations for the slaughter of ostriches. Therefore, Defra have produced guidance on the slaughter and handling of ostriches (Defra 2003) that gives clear guidance on the handling and slaughter of ostriches in order to meet welfare needs. They also recommend that, although ostriches are legally classed as poultry, they should be regarded as red meat at slaughter and stunned and slaughtered individually. The usual method of slaughter of ostriches is through exsanguination preceded by electrical stunning (Adams & Revell 1998). Once the birds have been stunned they are shackled by both legs and hoisted for bleeding out (Lambooij *et al* 1999b).

As discussed above, transport has been found to be stressful for ostriches. Therefore, many facilities offer de-stressing paddocks at lairage for birds after their journey (British Domesticated Ostrich Association [BDOA] 2002). These can take the form of small pens where the ostriches are kept overnight in groups, provided with water but not food (Sales 1999).

It is recommended that the birds are moved from lairage to the stunning pen in a calm, unhurried manner and should not be separated from their familiar group until they are placed in the stunning pen (Defra 2003). It is also suggested that hooding the birds at this stage may help to reduce stress (as long as the hood is removed before stunning) (Defra 2003).

Ostriches are stunned either electrically or with a captive bolt (Lambooij *et al* 1999a). However, Defra (2003a) recommended that electrical stunning should be used rather than mechanical stunning. As ostriches behave physiologically more like poultry than red meat (Wotton & Sparrey 2002) a similar method of stunning is recommended.

There is disagreement in the literature regarding the minimum electric current required to effectively stun ostriches. Wotton and Sparrey (2002) conducted a commercial trial of stunning practices in an abattoir in South Africa to determine suitable stunning currents and stun to stick intervals. They found that as the stunning current was increased (current ranged from 99 to 887 mA), the incidence of birds showing rhythmic breathing movements before exsanguination decreased. There was also an increase in the amount of rhythmic breathing as the stun to stick interval increased. From the results, they suggested that a minimum stunning current of 400 mA would induce an effective stun in 90% of ostriches provided that the stun to stick interval was no longer than 60 s. This is in line with Defra (2003a) who also suggest a minimum stunning current of 400 mA. However, other studies have recommended that at least 500 mA should be used to achieve effective stun for all birds (Lambooij *et al* 1999b) and that the stun to stick interval be no longer than 20 s (Adams & Revell 1998).

Not only could increasing the recommended stunning current and reducing the stun to stick interval improve bird welfare at slaughter but the ante mortem treatment of ostriches may also affect meat quality. It has been reported that the use of a high electrical current at stunning and a short stun to stick interval can positively affect some meat quality parameters (Lambooij *et al* 1999a). However, Lambooij *et al* (1999a) indicated that more research in this area is required to verify these findings.

There is little research on the use of mechanical stunning in ostriches but Lambooij *et al* (1999b) suggested that air pressure stunning may be an alternative to the use of elec-

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trical stunning but that more research was required for the development of suitable stunning and restraining devices.

Although there has been some research into the welfare of ostriches during transport and at slaughter, many of the results are discordant. More research is therefore required, particularly on posture during transport and stunning methods.

Buffalo

Buffalo are a common, agricultural animal in many locations around the world, especially in Asia, and over the centuries have become a domesticated, agricultural animal used for both meat and milk. All domesticated buffalo derive from the Asian buffalo (*Bubalus arni*) as opposed to the African species (*Syncerus caffer*) which have remained wild. Domestic Asian buffalo are broadly classified into river and swamp varieties with river buffalo having higher milk yields (Ranjhan & Pathak 1993). Buffalo have been farmed in the UK since 1991 (Anon undated). This species is promoted on factors such as the low cholesterol and fat content of the meat. Joksimovic and Ognjanovic (1977) found that the protein content of buffalo meat was higher than that of Simmental cattle. In addition, this species is free from bovine spongiform encephalopathy. In terms of management, these animals are said to experience good forage conversion rates and infrequent calving problems (Anon undated).

There is limited information on the management of buffalo for commercial production in European countries, with most available information relating to the extensive systems of Asia, and there is no research investigating welfare comparisons between buffalo and cattle. However, in Europe the recent development of the mozzarella cheese industry from low-level extensive systems to a more intensified industry means that buffalo are now being kept as a highly commercial enterprise.

There is little information on transportation of this species. In indigenous countries buffalo are renowned for their ease of herding and transportation (Cockrill 1974). In India buffalo are transported in lorries and train wagons, sometimes for several weeks, with no weight loss. Indeed, these animals may be transported eight per wagon, along with calves, and milk produced during the journey will be sold along the route. The only possible sign of increased stress is a reduction in lactation in some individuals (Cockrill 1974; Ranjhan & Pathak 1993). However, current road haulage practices in European countries are a much faster-paced affair and much of this information is anecdotal in nature. Chandra and Das (2001a) conducted the first systematic study on transportation of river buffalo. They looked at the behaviour of 100 animals during 30 min, 20 km journeys in a cattle truck. During the journey some animals showed physiological signs of stress, including eye congestion, lacrimation and nasal discharge. Behavioural signs of stress were observed with 80% of animals showing loss of balance, during cornering and braking, and a higher than average frequency of urination and defecation. Interestingly, some animals changed their orientation within the truck to a variety of positions parallel, perpendicular and diagonal to the length of the vehicle. However, most animals took up a parallel position. They also found that handling, loading and transportation resulted in bruising of the animals. Each buffalo had, on average, 2.44 bruises, with most (90%) being found in muscle tissue and resulting in economic loss on the carcass (Chandra & Das 2001b).

Italian researchers have investigated the effect of space allowance of housing on the physiology and behaviour of water buffalo calves (Grasso *et al* 1999; Napolitano *et al* 2004). In their most recent study Napolitano *et al* (2004) found when assessing buffalo welfare that behavioural indicators of stress, such as increased levels of aggression and reduced time spent lying, were more apparent than physiological changes when the stressor of reduced space allowance was applied.

Bison

Since the 1990s bison have become more common as a production meat animal (Agabriel *et al* 1996). However, most of our knowledge of this species comes from the ranching industry on the American prairies. There is very little published scientific information on the management of this species in terms of their handling, transportation and slaughter. Lanier and Grandin (Undated) have presented some information on the handling of American bison. Although these animals are calm when out in pasture, they noted that they can show behaviours such as stampeding and aggression when handled. Indicators of fear in bison are listed as licking, blinking, huddling, raised tail, circling, backing up and baulking. In cases of extreme fear indicators such as increased breathing, frothing at the mouth, vocalising, bulging eyes, running, pushing, goring, attacking, sitting, jumping and climbing out of the enclosure have been described (Lanier & Grandin Undated).

Bison are best moved out of sight of human handlers using solid walls to make the animals feel secure. Bison prefer to be in a group and become fearful and aggressive if held individually. Unlike cattle, bison do not follow one another in line and herding bison in single file can lead to the animals climbing over each other (Lanier & Grandin Undated).

Lanier *et al* (1999) have investigated the use of training to decrease the animals' fear and stress during handling procedures. They rewarded standing behaviour exhibited by bison calves with food treats and linked this reward to hearing a whistle being blown. They found that trained calves were less agitated than untrained calves when confronted with a new experience such as head restraint.

Clearly, although the number of bison and buffalo in the UK is increasing there is very limited knowledge on the best methods of handling, transporting and slaughtering them.

Animal welfare implications and recommendations

In order to address the deficit in understanding at both the academic and practical level, and to safeguard the welfare

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of these species, a number of recommendations have been identified.

Generally, all non-traditional farm species need up to date, species-specific codes of practices and legislation to be adhered to by producers, transporters and abattoir personnel.

Although there is some provision for the welfare of deer, recommendations to further improve the welfare of deer during transport and at slaughter are as follows:

- Research into methods of decreasing stress during transport, especially at loading and unloading by unfamiliar personnel.
- Training of hauliers in transportation of deer to include effects of driving technique, position within vehicle and group composition.
- Research into the effects of transportation on non-red deer species and wilder deer.
- Research into lairage set up for deer and investigation into optimal lairage duration.

More research is needed on all aspects of the management of wild boar, not just relating to transport and slaughter although these are areas of concern. In particular:

- Research into effects of transportation stress on welfare and meat quality.
- Training of abattoir personnel in handling of wild boar.
- Investigation into methods to increase ease of handling.
- Research into appropriate stunning methods for this species.

The welfare of ostriches during transport and at slaughter has been more thoroughly researched but clarification of suitable practices is required:

- Research into the effects of transportation on welfare and meat quality especially with increased journey times, group composition and vehicle type.
- Investigate ways of decreasing loading and unloading stress especially in terms of handling methods.
- Training of hauliers and abattoir personnel in terms of bird-handling techniques.
- Further research into whether birds should be allowed to sit down during transport and whether practices can be developed so that birds can do this safely.
- Investigation into appropriate lairage conditions.
- Further research into current requirements for stunning and stun to stick interval.

As with wild boar, much more research is needed on all aspects of the management of buffalo and bison. In particular:

- Research into transportation methods and their implications in European countries. This should include journey length and road type.
- Investigation and subsequent training of abattoir personnel in methods to increase ease of handling of buffalo.
- Investigation into lairage facilities for buffalo and bison.
- Investigation into appropriate stunning methods for these species.

Conclusion

The number of non-traditional farm livestock being produced in the UK has increased in recent years. Most research in this area has focused on red deer and ostriches but there is very little scientific research on wild boar, buffalo and bison relating to their welfare, particularly during transport and at slaughter. As there is little legislation and few related codes of practice for low-volume farmed livestock there is a danger that inappropriate transport and slaughter practices are being used in what is a growing animal industry. It is important that research is conducted to establish the needs of each species during transport and at slaughter and that transport and abattoir personnel receive training on suitable handling methods in order to ensure the welfare of low-volume farmed species.

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