

# UNCAGING NEW ZEALAND'S SOWS:

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SCRUTINISING  
FARROWING CRATES

Report by **Professor Andrew Knight**

## Report by

**Andrew Knight** BSc (Vet Biol), BVMS, MANZCVS, DipECAWBM (AWSEL), DipACAW, PhD, FRCVS, SFHEA

Andrew is Professor of Animal Welfare and Ethics, and Founding Director of the Centre for Animal Welfare, at the University of Winchester, UK; a New Zealand and American Veterinary Specialist in Animal Welfare; an EBVS European and RCVS Veterinary Specialist in Animal Welfare Science, Ethics and Law; a Fellow of the Royal College of Veterinary Surgeons; and a Senior Fellow of the UK Higher Education Academy.

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## SAFE

PO Box 28110,  
Wellington, 6150  
T: 04 472 9311  
safe@safe.org.nz

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# Executive Summary

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The close confinement of sows within farrowing crates is one of the most serious animal welfare problems in New Zealand today. Each year, around 15,000 sows are confined within metal cages barely larger than their own bodies, in a practice claimed to decrease piglet mortality. Genetic selection for high productivity has led to litters of 12-13 piglets in sows that weigh a staggering 260 kg on average (Calderón *et al.*, 2014), and in some cases, considerably more. Severely restricting the ability of sows to move within farrowing crates can decrease the risk of them accidentally crushing their own piglets, thereby increasing the productivity of the system.

However, being so tightly confined and with access to minimal amounts of straw (if any), these sows are unable to forage, to root within natural substrate to any meaningful degree, to engage in normal social interactions, or to fulfil their highly motivated natural instincts to build nests prior to giving birth. They are unable to make environmental and behavioural choices for their thermal and physical comfort (for example, avoiding draughts when cold, seeking shade and wallowing in pools when hot, or seeking comfortable surfaces to lie on). This can result in heat or cold stress (AHAW, 2007b: 37). The severe spatial restriction and hard surfaces on which they lie (concrete is common) contribute to injuries, reduced cardiovascular fitness, and poor leg health. Their severe lack of stimulation, exacerbated by restricted feed, results in unremitting weeks of boredom for these highly intelligent animals. New Zealand's Code of Welfare (Pigs) allows 95% of these pigs to be confined like this from five days prior, until around four weeks after they give birth. Five per cent of them may be confined for one additional week for cross-fostering purposes.

This is frustrating and stressful for the affected sows (AHAW, 2007a). Under these circumstances, a sows' natural foraging behaviour is redirected towards

restlessness, aggression, and pathological oral/nasal behaviours (stereotypies), such as bar-biting, chewing, licking and rubbing (Terlouw *et al.*, 1991; Lawrence and Rushen, 1993; Terlouw and Lawrence, 1993; Broom *et al.*, 1995; Spooler *et al.*, 1995; Vieuille-Thomas *et al.*, 1995; Rushen, 1984, 1985, Weber, 1984; Damm *et al.*, 2003; McGlone *et al.*, 2004; McGlone, 2013; Chapinal *et al.*, 2010).

Numerous studies of piglet mortality exist. These show considerable variability in performance results amongst different systems, with some non-crate systems showing higher piglet mortality, others on a par with crates, and some actually showing lower piglet mortality levels than farrowing crates.

There are numerous other strategies that exist which are far more humane, and can and should be pursued, to minimise piglet mortality. These include genetic selection for protective sow behaviours, smaller sows, healthier sows, and smaller litter sizes. Also important is attention to management factors such as hygiene, nutrition, vaccinations, minimising physical and social stressors, and the provision of adequate nest-building material and environmental enrichment. These are all important factors that may impact the physical and psychological health of sows.

New Zealand's regulatory framework intended to protect animal welfare consists of the Animal Welfare Act 1999 (hereafter, the 'Act'), the Codes of Welfare (notably, the Code of Welfare (Pigs) 2010 - hereafter, the 'Code'), and animal welfare regulations created by the Ministry for Primary Industries. Unfortunately however, in multiple important respects, these regulatory instruments fall well short of the standards necessary to adequately protect the welfare of sows confined within farrowing crates. To redress these deficiencies, several changes are clearly warranted.



# New Zealand's Pork Industry

## New Zealand pork production

Globally, there are around one billion pigs, which produce the largest meat tonnage (40%) of all farmed species, and this proportion is increasing. In New Zealand, 47.7 tonnes of pig meat was produced in 2010, of which 4% was exported to the Pacific and Asia, with the rest consumed domestically (along with pig meat imported from Australia, North America, China and the Netherlands).

Per capita consumption of pork is 20 kg annually in New Zealand, compared with chicken (33 kg), beef (27 kg) and sheep meat (12 kg). However, New Zealand pork consumption is much less than in Europe (Switzerland 42 kg, The Netherlands 43 kg and Germany 53 kg), the US and Canada (each 28 kg).

Pork's farm gate value in New Zealand is around \$150 million annually, with a retail value of around \$500 million. The industry is reportedly worth more than \$1 billion overall, through sales, employment and ancillary expenditure (Stafford, 2013).

## National herd characteristics

New Zealand pig production has historically centred around dairy farming regions such as Waikato, Taranaki, Manawatu, Bay of Plenty and Southland, with skim milk and whey used as feed, or around grain growing regions such as Canterbury, with grain fed to pigs. Today most New Zealand pigs are fed barley-based or compound meals (Stafford, 2013).

By 30 June 2016, there were 24,300 breeding sows (aged one or over) in New Zealand, of which 10,000 (41.1%) were in the North Island, and 14,300 (58.8%) in the South. This represented an 8.4% total

decrease compared to the previous year. Most of these sows (16,064) were housed in 46 large farms (defined as housing more than 50 sows). In 2015, each of these larger farms housed an average herd of 349 sows (Yap *et al.*, 2015: 20).

During the year ending 30 June 2016, 562,200 piglets were weaned – a 1.6% decrease compared to the previous year (Stats NZ, 2017: Table 7). In the year ending September 2017, 659,984 pigs were slaughtered (MPI, 2017). Over the last decade, NZ pig numbers have fallen. In contrast, in 2007, 40,000 sows on 360 farms produced 770,000 pigs (Stafford, 2013).

In New Zealand, about 60% of all pork production units use farrowing crates (Welch, 2012). The remainder produce pork in extensive outdoor systems (Chidgey *et al.*, 2015).



Farmwatch - Waikato 2015

# Pig Reproductive and Social Behaviour



Farmwatch - Waikato 2017

Any consideration of the adequacy of various housing systems for farrowing sows and their piglets must start with a consideration of natural pig reproductive behaviour. Accordingly, key characteristics of pigs and their behaviours are reviewed in the following.

## **Key cognitive, social and behavioural characteristics**

The domestic pig originates from the wild boar (*Sus scrofa*) (Johnson and Marchant-Forde, 2009), with the first phase of domestication occurring around 9,000 years ago in the Near East. Further domestication events followed, with considerable crossbreeding between Asian and European pigs, until the modern *Sus domesticus* emerged (Marino and Colvin, 2015).

Pigs were domesticated primarily to serve as a food source. Hence, domestication selected primarily for traits promoting growth and reproduction. Wild boars average three to five piglets per litter (Harris *et al.*, 2001), but genetic selection for high productivity has resulted in 12-13 piglets for modern farmed sows (e.g. in Sweden) (Quality Genetics, 2010).

In contrast, the cognitive and behavioural capacities of domestic pigs remain relatively unchanged from their wild forbears, with retention of many of the instincts, motivations, and sensory abilities that enable wild boars to survive. Pigs are highly social animals that naturally live together in small maternal groups consisting of three to four females and their offspring. Adult males join when the sows are in heat (Johnson and Marchant-Forde, 2009).

Research strongly indicates that pigs are highly intelligent. They are adept at solving mazes and object location tests, have excellent long-term memories, and seem to love playing. They recognize each other as individuals, and can recognize a simple symbolic language. They appear to feel a range of emotions, and to respond to each other's emotional states. They also have the capacity to gauge the mental perspective of other pigs (Marino and Colvin, 2015).

Pigs have their highest density of tactile receptors in their snouts, which are used to root, carry, and push items, and to interact with others. Olfaction is a pig's keenest sense, and is used to identify fellow pigs, determine each other's state of sexual arousal, and even detect each other's emotions during aggressive encounters. In social contexts, pigs also use their sense of hearing. Mother pigs and their offspring communicate by vocalizing in ways that may be unique to each individual, and pigs can determine the identity and arousal state of individuals by listening to each other's voices. Pigs can also recognise humans, and, like wild boars, can show signs of distress in highly artificial settings (Marino and Colvin, 2015).

### **Natural maternal behaviour**

The natural behaviour of pigs prior to and following birthing comprises of several distinct stages (Jensen, 1988a).

#### ***Social isolation***

Around 24-48 hours prior to the birth of their first piglet, the sow will leave the social group and seek isolation. The importance of isolating themselves is demonstrated by the 2.5-6.5 km that sows are reportedly willing to walk (Jensen, 1986; Jensen et al., 1987). The resultant nests are generally outside normal home ranges (Jensen, 1988a; Jensen, 1993), and it has been hypothesized that this isolation allows the sow and piglets time to learn to recognize each other, and to avoid cross-suckling (Jensen, 1986).

### ***Nest planning and construction***

Sows go to considerable effort to plan and construct nests. Numerous potential sites are normally inspected, and the chosen site usually provides a degree of vertical and horizontal protection, as well as some sloping ground (Jensen, 1986; 1989), facilitating drainage. The site is then hollowed out by rooting to a depth of 5-10 cm. Grasses, roots and leaves are collected and used to line the nest. The resultant walls are usually structurally sound with well-formed sides. Larger branches are then arranged over the top, and grass and other fine materials are used to form a roof.

The time and effort involved is considerable – as illustrated by the single nest from a free-ranging sow in Brazil, which was recorded as containing 255 kg of plant material (Zanella and Zanella, 1993).

### ***Farrowing***

Farrowing often begins within a few hours after nest-building. The sow is unusually passive. She will often stand, turn and sniff the first piglets born (Jensen, 1986; Petersen et al., 1990), but will otherwise carry out few postural changes. This passivity continues after farrowing, with relative inactivity persisting for 90-95% of the first 48 hours (Johnson and Marchant-Forde, 2009). Jensen (1988b) has hypothesized that this inactivity may be a behavioural adaptation to reduce crushing risks given her sizeable litter of relatively small infants, and to allow the establishment of a teat order.

### ***Nest Occupation***

Nest occupation persists for seven to ten days after farrowing is complete. After the first two days, time spent outside gradually increases. The sow may also perform nest repairs as needed, and if necessary (e.g. following heavy rainfall), the sow may build a completely new nest and move her piglets (Stangel and Jensen, 1991).

### ***Suckling behaviour***

Sows nurse their piglets frequently during the first days of life. Nursing is initiated either by the sow lying on her side and presenting her teats, or by the piglets squeaking at her head and/or massaging the teat area. Eventually the whole litter vigorously butts and jostles for a position at the mammary glands (Johnson, 2001). The piglets may vocalize intensely and continually (Appleby *et al.*, 1999). During nursing the whole litter quiets however, with each piglet suckling a nipple whilst the sow grunts rhythmically. Nursing may last for less than one minute, or up to several minutes. It ends when the piglets either detach themselves, or the sow stands up or rolls onto her belly to hide her teats (Johnson, 2001).

### ***Social Integration***

After approximately seven days, the piglets leave the nest and start to follow their mother. They are then gradually introduced to the family group towards the end of the second week (Jensen, 1988b). This allows time for family bonding to be completed

before introduction to other litters. Thereafter, social interactions shift away from litter-mates and move towards piglets of a similar age (Petersen *et al.*, 1989). Accordingly, when designing group farrowing accommodation, it would seem appropriate to allow mixing of litters prior to weaning, but not prior to about 14 days after birth (Rudd, 1995; North and Stewart, 2000).

### ***Weaning***

Natural weaning is similarly gradual. Suckling frequency declines gradually from the first week, and the number of suckling events terminated by the sow increases (Jensen *et al.*, 1993). Piglets start consuming solid food from around four weeks after birth, and by eight weeks this constitutes a large proportion of the piglets' diet (Jensen, 1995). Piglets start to miss suckling sessions and weaning is completed anywhere from eight weeks (Newberry and Wood-Gush, 1985) to 19 weeks postpartum (Jensen and Stangel, 1992), with large variations possible within a single litter (Jensen, 1995).

## Industry Intensification: Welfare Concerns

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Historically, farmed pigs lived outdoors in sties and loose boxes. However, during the 1950s, industrial processes and production philosophies developed during World War II were widely applied to animal farming, resulting in greater efficiency and intensification of production. Within the pig farming sector, indoor housing systems were developed, utilising specialised housing, diets and health management. This allowed large herds to be housed in limited spaces, and increased feed conversion efficiency and growth, resulting in greater productivity and efficiency. This was assisted by genetic selection

of strains and breeds for factors such as greater litter sizes and growth rates. Sows today weigh a staggering 260 kg on average (Calderón *et al.*, 2014) – and in some cases, considerably more. The average litter size has also increased from under 11 to over 13 (Einarsson *et al.*, 2014). Moustsen *et al.* (2004) calculated that sows in the 95% percentile (i.e. smaller than only 5% of sows), weighed 352 kg. In the year ending Sep. 2017, the average carcass weight for pigs slaughtered in NZ had risen to 71.1 kg (MPI, 2017) – an increase from 56.7 kg in 1990 (Stafford, 2013).

However, the unnatural housing and management regimes developed also gave rise to a range of serious animal welfare problems for farmed pigs. These include significant piglet mortality, stresses associated with early weaning, painful husbandry procedures such as tail docking, tooth clipping and nose ringing, transmissible diseases, lameness and other physical problems, and movement, behavioural and social restrictions associated with close confinement, as well as adverse consequences such as increased aggression, tail and vulva biting, and stereotypical behaviours. The latter are repetitive, apparently

purposeless behaviours such as bar-biting, which are believed to indicate both profound and chronic (long-term) stress. Additional welfare concerns relate to handling by stockpersons, the stressors associated with transportation and slaughter (Stafford, 2013), and to death at an early stage of life (Yeates, 2010).

Within New Zealand, the most serious animal welfare concerns relate to the close confinement of sows within farrowing crates. Such farrowing crates and alternative housing systems provide the focus for the remainder of this report.

## Farrowing Crates: Welfare Concerns



Farmwatch - Waikato 2017

Pig housing varies widely between farms in New Zealand, and sometimes even within the same farm. Sows may be housed outdoors, indoors, in stalls, in small pens with few companions, or in large bedded open sheds with tens of animals. As Stafford (2013) states, "... in reality sows may be in houses of almost any design imaginable." Housing systems may upgrade as farms increase in size and become better capitalised, may change from outdoor to indoor, and from stalls to small

pens, and then to large sheds. Sheds may be naturally ventilated or environmentally controlled, and may have flooring of concrete, with or without slats, sawdust or straw bedding (Stafford, 2013).

Farrowing crates were developed in the 1940s to limit sow access to her piglets. Sows are moved into these crates a few days prior to farrowing, give birth whilst confined in them, and are confined thereafter for varying

lengths of time – usually, up to four weeks, under the Code (NAWAC, 2010: 19). However, all sows may be confined for an additional five days prior to farrowing, and 5% of the sows in a herd may be confined for an additional week for cross-fostering purposes. Hence, some of these sows may be confined for almost six weeks. Although the Code does recommend that sows should not be confined in crates for more than 10 days after farrowing (NAWAC, 2010: 20), this is a recommendation only, and has not been included as a required minimum standard. Hence, it is unenforceable.

Farrowing crates are typically around 2.1 x 0.9 m in size, and are placed centrally, or offset in a pen that has additional space for the young piglets. This may include a creep area, commonly providing a heat source such as a hanging lamp or heat pad within an enclosed area, given the higher temperature requirements of piglets. Crate flooring can be partly or fully slatted, and bedding, straw or other manipulable materials are not provided most of the time (AHAW, 2007b: 14). Farrowing crates are used to restrict sow movement, which in some systems may reduce piglet mortality (Stafford, 2013).

Unfortunately, however, sows confined in farrowing crates experience a number of animal welfare problems, some of which are severe.

### Confinement

Static space requirements for sows may be calculated by considering bodily dimensions, but the dynamic space required in order to move is harder to calculate. Moustsen *et al.* (2004) determined that 95% of Danish crossbred sows introduced to the farrowing house measured less than 200 cm (mean = 184) in length and less than 47 cm (mean = 42) in width across the shoulders. This concurred with American equivalents (McGlone *et al.*, 2004). These data were used to estimate that a 350 kg sow needs at least 2.44 square metres of floor space to comfortably get up and lie down (2.65 m long x 0.92 m wide x

0.97 m high). To turn around, more space is required. According to Baxter *et al.* (2011), the minimum space required for a sow to turn around unimpeded is 4.9 square metres.



Most sows today are longer and taller than those used 15 years ago, and may be farrowing in older crates designed for smaller sows (Moustsen *et al.*, 2011). Many can barely take one step forwards or backwards, and cannot even turn around. Sows may experience difficulty standing up and lying down, exacerbated by the adverse effects of exercise deprivation and movement restriction on limb health and muscular strength (AHAW, 2007b: 29). Occasionally injuries can result where the sow is simply too big for the crate.

The space requirements of pigs were studied in detail by the European Food Safety Authority's Scientific Panel on Animal Health and Welfare (AHAW, 2005). To meet all the needs of a pig, substantially more space is needed than indicated even by dynamic space calculations. New Zealand's National Animal Welfare Advisory Committee (NAWAC) (2010: 12) believes current industry guidelines for space requirements warrant review, and that 10-50% more space may be required to provide for all pigs' needs, depending on their activity level and thermal conditions.

Unfortunately however, most crated sows today are closely confined within highly restricted barren environments, with little in the way of manipulable substrates or other forms of stimulation. These conditions create several serious welfare problems.

### Comfort

Pigs normally make environmental and behavioural choices to facilitate their thermal and physical comfort (for example, avoiding draughts when cold, seeking shade and wallowing in pools when hot, and seeking comfortable surfaces on which to lie). Sows increasingly prefer to lie on a cool floor during the course of their lactation – however crate confinement can impede their thermoregulatory ability (Phillips *et al.*, 2000). This can result in heat or cold stress (AHAW, 2007b: 37).

### Injuries

Because of severe spatial restriction, crated sows often bump parts of their body when lying down or standing up (Troxler and Weber, 1989; Harris and Gonyou, 1998). Although sharp edges should be absent, the hard surfaces these sows unavoidably encounter (e.g. metal bars and the common use of concrete floors on which they lie), can contribute to injuries. Bonde *et al.* (2004), for example, found that problems in lying down behaviour were associated with injuries in sows housed in farrowing crates. Skin lesion scores of sows are increased after 24 hours in the crate (Boyle *et al.*, 2000), and the prevalence of wounds remains elevated, until weaning takes place (Boyle *et al.*, 2002). Shoulder lesions (decubitus ulcers or pressure sores; Zurbrigg, 2006), hock, foot, claw and teat lesions, are also relatively common in crated sows (AHAW, 2007a; FAWC, 2015). These may include pressure sores, joint injuries and lameness. Exacerbating factors include high sow body weight, and poor fitness resulting from exercise restriction.

### Health and disease

The detrimental effect of crating sows on foot and leg pathology, and on maintenance of muscle mass, is commonly reported as a consequence of reduced exercise over time (Barnett *et al.*, 2001). Leeb *et al.* (2001) suggested that the opportunity to move around reduces the incidence of callosities. Confined sows have been shown to have reduced cardiovascular fitness (Marchant *et al.*, 1997), reduced bone strength (Marchant and Broom, 1996) and increased morbidity (Bäckström, 1973). These factors are mutually reinforcing. Crated gilts compared to those housed in pens or dirt lots stood up less, and lay down more and for longer periods (Taylor *et al.*, 1988), presumably due to discomfort and decreased fitness – further exacerbating that lack of fitness.

Multiple aspects of farrowing crates can increase disease risks for sows, including design factors affecting hygiene (e.g. reduced slatted floor area for faeces removal), capacity of the sow to make thermal and physical comfort choices, housing induced injuries (FAWC, 2015), stress, and consequent immunosuppression. On the other hand, systems facilitating ease of access for stockpeople may also make treatment easier, when necessary.

### Natural behaviours

#### *Exploratory behaviour*

Pigs are very curious and intelligent, and are highly motivated to perform natural behaviours such as foraging, investigating and exploring their environment, and to manipulate natural materials such as leaf litter with their mouths and snouts. When kept in a semi-natural enclosure, exploratory and foraging behaviour accounts for a large proportion (up to 75%) of pigs' daily activities (Stolba and Wood-Gush, 1989). Ladewig and Matthews (1996) demonstrated that pigs are highly motivated to work for access to foraging material, like straw or wood shavings.

Accordingly, manipulable material should be provided to sows. A substrate is suitable if it is complex (Olsen *et al.*, 2000), can be bitten (Grandin and Curtis, 1984b) or chewed (Feddes and Fraser, 1994; Fraser *et al.*, 1991; van de Weerd *et al.*, 2003), is easy to manipulate (Grandin and Curtis, 1984b), is changeable (Grandin and Curtis, 1984a; Fraser *et al.*, 1991; Feddes and Fraser, 1994; Blackshaw *et al.*, 1997; van de Weerd *et al.*, 2003), and if some part of it is edible (Young *et al.*, 1994; van de Weerd *et al.*, 2003). Preference tests have indicated that pigs value peat, compost, green branches and various wood chips above straw, and that indestructible materials such as plastic, rubber and chains (commonly provided in pens as 'enrichment') are valued less than straw (Pedersen *et al.*, 2005; Studnitz *et al.*, 2007).

In addition, the high-energy grain-based mixed feeds commonly used are quickly digested, resulting in long-term periods of hunger if not used in combination with other feeds (Robert *et al.*, 1997; Bergeron *et al.*, 2000). This means that sows are still motivated to forage, and will attempt to perform foraging behaviour.

Unfortunately however, New Zealand's Code requires the provision of manipulable substrates only until farrowing, and only in farrowing crates constructed after 03 Dec. 2010 (NAWAC, 2010: 19). Hence, sows are normally deprived of these materials for most of their crated period. Their severe lack of stimulation, exacerbated by restricted feed, results in unremitting weeks of boredom. This is frustrating and stressful for the affected sows (AHAW, 2007a). Under these circumstances, their natural foraging behaviour is redirected towards restlessness, aggression, and oral/nasal stereotypies, such as bar-biting, chewing, licking and rubbing (Terlouw *et al.*, 1991; Lawrence and Rushen, 1993; Terlouw and Lawrence, 1993; Broom *et al.*, 1995; Spooler *et al.*, 1995; Vieuille-Thomas *et al.*, 1995; Rushen, 1984,

1985; Weber, 1984; Damm *et al.*, 2003; McGlone *et al.*, 2004; McGlone 2013; Chapinal *et al.*, 2010).

The piglets are also affected. Rooting behaviour begins in the first week of age (Petersen, 1994), and lack of appropriate substrates redirects piglet exploratory behaviour toward other pigs. Accordingly, sows in barren pens have more teat lesions, and a higher proportion of piglets have facial lesions (Lewis *et al.*, 2006) – which are normally caused by fighting.

Nevertheless, such deprivation within farrowing crates is the norm, even though provision of straw as a foraging substrate has been shown to reduce stereotypic chain and bar manipulation in pregnant sows (Fraser, 1975; Spooler *et al.*, 1995; Whittaker *et al.*, 1998).

### **Nest building**

Sows are also highly motivated by multiple hormonal factors to build nests. This natural behaviour requires both sufficient space, and sufficient availability of nesting material such as straw, or more natural materials such as branches, grass and twigs. Accordingly, multiple experts, such as the Scientific Panel for AHAW of the European Food Safety Authority, believe that farrowing systems should allow for the handling of destructible nest material to enable investigation and manipulation activities (AHAW, 2007a: 10). As mentioned, New Zealand's Code does require the provision of manipulable material until farrowing. However, natural nest-building utilises large quantities of branches, grasses, roots and leaves – which can total at least 255 kg of plant material (Zanella and Zanella, 1993). It is highly unlikely that the quantity and quality of material provided within farrowing crates is sufficient for natural nest-building behaviour, and the severe confinement also restricts such behaviour to occur. The inability to build a nest prior to birth is believed to be highly stressful, resulting in impaired welfare (AHAW, 2007a; FAWC, 2015).

### Social interactions

Sows are also motivated to interact socially with their piglets and other pigs. However, the sow's ability to interact with her piglets, including suckling, is another factor restricted by space limitations and the bars of her cage.

Additionally, crates may worsen aggressive interactions between sows. Dolf (1986) found that the average duration of aggressive interactions increased when sows were crated, compared to group housed animals. The crated sows continued

their aggressive interactions for at least three days, whereas aggression between animals housed in groups 'diminished rapidly'. Broom *et al.* (1995) also found that aggression of crated sows was more frequent, and escalated to a higher level, compared to group housed sows. It is likely that crates impede the expression of behaviours that would naturally resolve aggression, such as the retreat of subordinate animals (Dolf, 1986). This is likely to increase stress hormones (Barnett *et al.*, 1987). However, crates do prevent the infliction of physical injuries that can be caused by aggression.



Farmwatch - Taranaki 2014

### Stress

Crated sows have increased heart rates (Damm *et al.*, 2003a) and elevated levels of plasma cortisol concentrations (a stress hormone) (Lawrence *et al.*, 1994; Jarvis *et al.*, 1997, 2001) during the pre-birth period, compared to loose-housed sows. Similarly, Jarvis *et al.* (2006) found that cortisol levels following exposure to a stimulating hormone

(corticotropin-releasing hormone) on day 29 of lactation, were higher in sows housed in crates, compared to pens. This indicates increased activity of the hypothalamic pituitary adrenal (HPA) axis, which is central to the mammalian stress response. These findings jointly indicate that sows suffer stress throughout the duration of their confinement within farrowing crates.

**Sows are confined in farrowing crates for 4-6 weeks, experiencing many welfare problems, some of which are severe**

Skin lesions, ulcers and pressure sores are common, together with joint injuries and lameness.

Sows in crates suffer reduced cardiovascular fitness, reduced bone strength and lie down more than loose housed animals.

The crate is only just bigger than the size of the sow herself. Some larger animals can be injured by the bars when lying down.

Sows are usually given minimal bedding; just a hard floor to stand and lie down on.

Movement is restricted to standing up and lying down, often with difficulty, and barely a step forward and back.

Pigs are highly intelligent more so than dogs and the confinement in crates causes severe boredom and frustration. This often leads to repetitive behavior including bar biting and chewing.

Increased heart rates and levels of stress hormones have been measured in crated sows, compared with those housed in loose pens.

Sows given common, rapidly digestible grain-based foods without other supplementation can be hungry for much of the time.

They are unable to turn around.

The pigs are prevented from building a nest prior to the birth of their piglets, which is very stressful.

Limb health and muscular strength is compromised, caused by exercise and movement deprivation.



**Figure 1:** Welfare problems experienced by crated sows  
Sows are typically confined in farrowing crates for 4-6 weeks, 2-3 times each year.

# Housing Design Criteria

The multiple, serious, welfare problems associated with farrowing crates create a strong impetus for the design of alternative systems. Many different design objectives exist for farrowing and lactating sow housing, some of which are contradictory. The sow has behavioural needs associated with developmental phases such as nest building, birthing and lactation, some of which may differ. The needs of piglets and sows can also differ, and those of piglets also change with development as they grow. For reasons of economics, systems should also be affordable to construct, robust to minimise repairs and maintenance, safe for personnel to work with, and designed to allow ease of cleaning and good hygiene (Stafford, 2013). However, as Baxter *et al.* (2011: 580) put it, "It is not unreasonable to suggest that agricultural practices in livestock farming systems should be based on the biological needs of the animals involved."

The housing characteristics required to meet these biological needs have been studied in depth, as exemplified by considering the needs of the sow in relation to nest building. Housing space, enclosure, substrate and flooring type all affect the sow's ability to exercise this highly motivated behavioural need (Baxter *et al.*, 2011). Considerations of space requirements alone illustrate how detailed the necessary design considerations may become.

Space provision is economically costly, so a financial incentive exists to minimise it. However, during the nest-building phase, space is required to allow the sow to increase its activity, to 'seek' a nest site, and then to build its nest. As mentioned previously, Moustsen *et al.* (2004) calculated that sows in the 95% percentile (i.e. smaller than only 5% of sows), weighed 352 kg. They were 2.00 m long, 0.47 m wide, 0.95 m tall and measured 0.71 m from middle to back (their breadth). These data were used to estimate that a 350 kg sow needs at least

2.44 square metres of floor space to comfortably get up and lie down (2.65 m long x 0.92 m wide x 0.97 m high). To turn around, more space is required (Robertson *et al.*, 1972). A planar width of 1.53 m and a planar area of 3.17 square metres, are required for turning around (Baxter *et al.*, 2011). However, sows today are larger than those studied in 2004. Additional space is also required to accommodate increased activity associated with 'seeking' a nest site, and with nest building.

Finally, additional space is required for feeding and excretory areas. Overlap of the nest and feeding area can divert the sow's attention and increase her physical activity within the nest space, increasing the already significant risk of smothering her piglets. And the overlap of nest and excretory areas will impair hygiene, increasing the risk of adverse health consequences, particularly for piglets after birthing and during lactation (Baxter *et al.*, 2011).

Design considerations relate not only to the quantity of space provided, but also to the nature of that space. Sows naturally choose nest sites that are isolated and at least partially enclosed, which seems to afford protection from inclement weather whilst also allowing the sow to maintain vigilance for potential approaching threats (Stolba and Wood-Gush, 1984). Hunt and Petchey (1987) demonstrated that sows always choose farrowing locations located inside, or against a solid wall, but never out in the open. This matches the choices of sows under natural and semi-natural conditions (Stolba and Wood-Gush, 1984), where 89% chose at least partial enclosure, and 40% chose total enclosure. These findings suggest that structures providing walls on three sides may be beneficial.

Choice of substrate is similarly important. A sufficient quantity of straw or similarly manipulable materials is

required to satisfy nest-building behaviour (Arey *et al.*, 1992). The precise quantity and nature of materials required remains the subject of significant research. Preference tests have also been conducted on flooring choices, with 100% of sows choosing to farrow in an earthen pen site that can be hollowed out, compared to a concrete floor (Haskell and Hutson, 1994). As well as allowing for greater physical protection, this could offer greater udder comfort for the sow, or lower thermal conductivity (Baxter *et al.*, 2011).

Floor design also affects hygiene, along with provision of space adequate for a separate dunging area. Perforated or slatted flooring results in superior hygiene to solid flooring (Rantzer and Svendsen, 2001), however this may also result in increased injury risks for both piglets and sows.

A similar set of biological needs must be adequately satisfied during the birth and lactation phases, for both sows and piglets. These may be summarised as in Table 1.

**Table 1.** Biological needs of sows and piglets

Housing System Component	Needs for Sows	Needs for Piglets
Space	<ul style="list-style-type: none"> <li>Increased activity for nest-site seeking</li> <li>Hygiene – dunging space</li> <li>Feeding and foraging</li> <li>Turn around nest space for piglet</li> <li>Inspection and gathering behaviour</li> <li>Lateral lying and birthing</li> <li>Thermal comfort via posture changes</li> <li>Nest departure</li> <li>Social contact</li> <li>Gradual separation from piglets and controlled nursing</li> </ul>	<ul style="list-style-type: none"> <li>Birthing process</li> <li>Udder access for suckling throughout lactation</li> <li>Protection, safe lying area for birthing process and nest occupation</li> <li>Protected lying area during lactation</li> <li>Area for feed trough to introduce creep feed</li> <li>Hygiene</li> </ul>
Substrate	<ul style="list-style-type: none"> <li>Nest-building – carrying and manipulating</li> <li>Nest completion phase</li> <li>Udder comfort</li> <li>Thermal comfort during nest building</li> <li>Thermal comfort during birthing</li> <li>Foraging material</li> </ul>	<ul style="list-style-type: none"> <li>Foraging, nutritional development</li> <li>Enrichment, social development</li> <li>Thermal comfort during birthing phase</li> <li>Physical comfort</li> <li>Protection</li> </ul>
Walls	<ul style="list-style-type: none"> <li>Enclosure/isolation of nest</li> <li>Darkness</li> <li>Visual and physical contact with non-litter pigs</li> <li>Supported posture changes</li> <li>Lack of disturbance</li> </ul>	<ul style="list-style-type: none"> <li>Protection from sow posture changes</li> <li>Social contact (visual and physical)</li> <li>Hygiene</li> <li>Thermal comfort</li> </ul>
Flooring	<ul style="list-style-type: none"> <li>Nest building – digging, rooting and hollowing</li> <li>Nest building and birthing</li> <li>Thermal comfort during nest building</li> <li>Thermal comfort during birthing</li> <li>Thermal comfort during lactation</li> <li>Physical comfort – avoiding injury, promoting suckling behaviour</li> <li>Hygiene</li> </ul>	<ul style="list-style-type: none"> <li>Thermal comfort during birthing phase and first 24h of life</li> <li>Thermal comfort during lactation</li> <li>Physical comfort – avoiding injury, promoting suckling behaviour</li> <li>Protection from fatal crushing by the sow</li> <li>Hygiene</li> </ul>
General	<ul style="list-style-type: none"> <li>Thermal comfort</li> <li>High feed intake</li> </ul>	<ul style="list-style-type: none"> <li>Health – treatment for injuries, vaccines, etc.</li> <li>Promote weaning, reduce nutritional stress and encourage increased feed and water intake</li> <li>Thermal comfort</li> <li>Hygiene</li> </ul>

Biological needs of sows and piglets during farrowing and lactation that should be met through appropriate housing design. After Baxter *et al.* (2011), who also provide more detailed design recommendations.

# Alternative Systems

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However, alternatives to the farrowing crate do exist, and are already used by many New Zealand pig farmers. These include solo pens, group pens, and free range systems, which are all described by Taylor and Roese (2006). The main alternatives include the following:

## **Solo pens**

Sow pens often have piglet protection bars around the walls 250 mm off the floor, and the sow is restrained during birthing by a hinged gate. Smaller pens are often designed with fully slatted floors to maintain hygiene. Larger pens allow the use of deep litter in a separate lying area, but require a higher labour input.

Production figures indicate that many solo pen designs perform as well as farrowing crates, and capital costs are often similar for both systems. Additionally, solo pens can also be used as weaner pens. Alternative designs may result in higher piglet losses through crushing, but there are often fewer stillbirths.

At present, there are a large variety of farrowing pen designs in use. Examples include:

## ***Kennel and run systems***

These have a straw-bedded kennel, and a solid or slatted floor run. The piglet creep area is isolated from the sow, and piglets may have restricted access to the sow feeding and dunging area. These units are most successful when the kennels have accurate thermal control.

## ***The Werribee pen***

This has two separate sow areas, one of which has a protected area for piglets. Whilst these pens show excellent performance, they require about double the floor space of conventional farrowing crates.

## ***Turn-around pens***

These are designed to allow the sow to turn near the rear of the pen.

## ***Sloped farrowing pens***

These have an 8° to 14° slope. The piglets tend to gravitate down the slope, which leads to a protected area.

## ***Freedom farrowing system***

This system, developed in New Zealand, confines the sow in a narrow area for farrowing and for a few days post farrowing (Stafford, 2013: 100). Thereafter the system is opened to allow greater movement and toileting in a separate slatted area. The piglets have a heated creep area. It is 3.35 m x 2.29 m in size, which is larger than a standard farrowing crate.

## **Group pens**

Sows housed within group pens have freedom of movement, freedom to choose nest sites, and share drinkers, feeders and dunging areas.

The disadvantages include increased fighting and a higher number of piglet mortalities, as sows become restless prior to farrowing, and interact. As mentioned previously, wild sows would seek to isolate themselves at a considerable distance from their herd. Increased sow aggression after

farrowing may also be directed towards staff, who in turn need excellent stock management skills.

Additional problems may be created by some piglets who take the opportunity to cross-suckle, creating differential growth rates.

Family pen systems were developed as an extension of basic group housing. Sows were kept in stable family groups throughout their production period, and a boar was allowed to run with the group and serve the sows whilst they were still lactating. Piglets were often weaned at 12 weeks. Major problems with this system however were poor synchronisation of sows for farrowing, and a high number of piglet mortalities.

To address the problem of piglet mortality in particular, numerous systems have been designed that combine some use of farrowing crates with deep litter group housing. Sows may be confined within crates with their piglets for around two weeks, which minimises crushing and allows cementing of the sow-piglet bond and development of a stable teat order. Thereafter, sows and their litters are moved to larger pens with deep litter, and are housed in a group, ideally with sows around the same age to minimise the risk of fighting. These systems have less piglet mortality, and reduced cross-suckling problems. Examples include:

#### ***The Vastgomodel system***

This Swedish deep litter farrowing system was designed to minimise pig stress, levels of feed, and antibiotic usage.

#### ***The Thorstensson system***

This is a version of the Vastgomodel system. Sows are allowed to select their own bedded farrowing cubicles. These are positioned on rollers, and are removed when piglets reach two weeks of age,

converting the system into a group pen. Sows are removed at weaning, and the group lactation pen becomes a weaner pen. The weaners are grown in this pen until 10–12 weeks of age.

This system has a lower capital cost compared with conventional systems, and has achieved good reproductive performance. However, pre-weaning mortality has been very high, and excellent stock management skills are mandatory.

#### ***The Ljungstrom system***

This is another version of the Vastgomodel system, in which sows initially farrow in conventional crates. When the piglets reach 10–14 days of age, the sows are moved with their litters to a group lactation pen. At this time, new sows with their litters can also be introduced. The sows are preoccupied with mothering, which minimises fighting. This system significantly reduces pre-weaning mortality, with piglet growth rates similar to those achieved by conventional systems. Producers in Iowa have achieved 24–27 pigs per sow annually using this system, with 8–10 sows per group (Taylor and Roese, 2006).

#### **Free range systems**

Outdoor systems have the benefit of minimising capital investment, making them relatively cheap to establish. They can provide more space, more natural surroundings, and more opportunity to express natural behaviours. As a result, outdoor systems can be considered very welfare-friendly, provided of course that they are well managed to minimise risks such as inclement weather and parasitism. Performance of these systems can often be similar to conventional farrowing crates. However, they do require mild climates (temperate, low rainfall), appropriate soil types to facilitate drainage, and shelters such as 'arks' or huts for protection from inclement weather.

Labour requirements are increased compared to indoor systems, and the necessary husbandry skillset differs somewhat. Outdoor sows may be fitted with nose rings – a painful procedure (Stafford, 2013: 100-101) – to inhibit natural rooting activity and maintain grass cover.

### **Sow housing in New Zealand**

In a survey of sow housing, Gregory and Devine (1999) contacted larger producers, who jointly

owned about 90% of the national herd. 56% of these sows farrowed in a crate, 24% outdoors, 15% in a pen, and 5% in other systems. When considering the national herd in its entirety, Stafford (2013: 95) reported that over 40% of New Zealand pigs are managed outdoors – a high figure compared to most other nations. In contrast, Edwards (2005) reported that in the UK, approximately 30% of the national sow breeding herd is housed outdoors.



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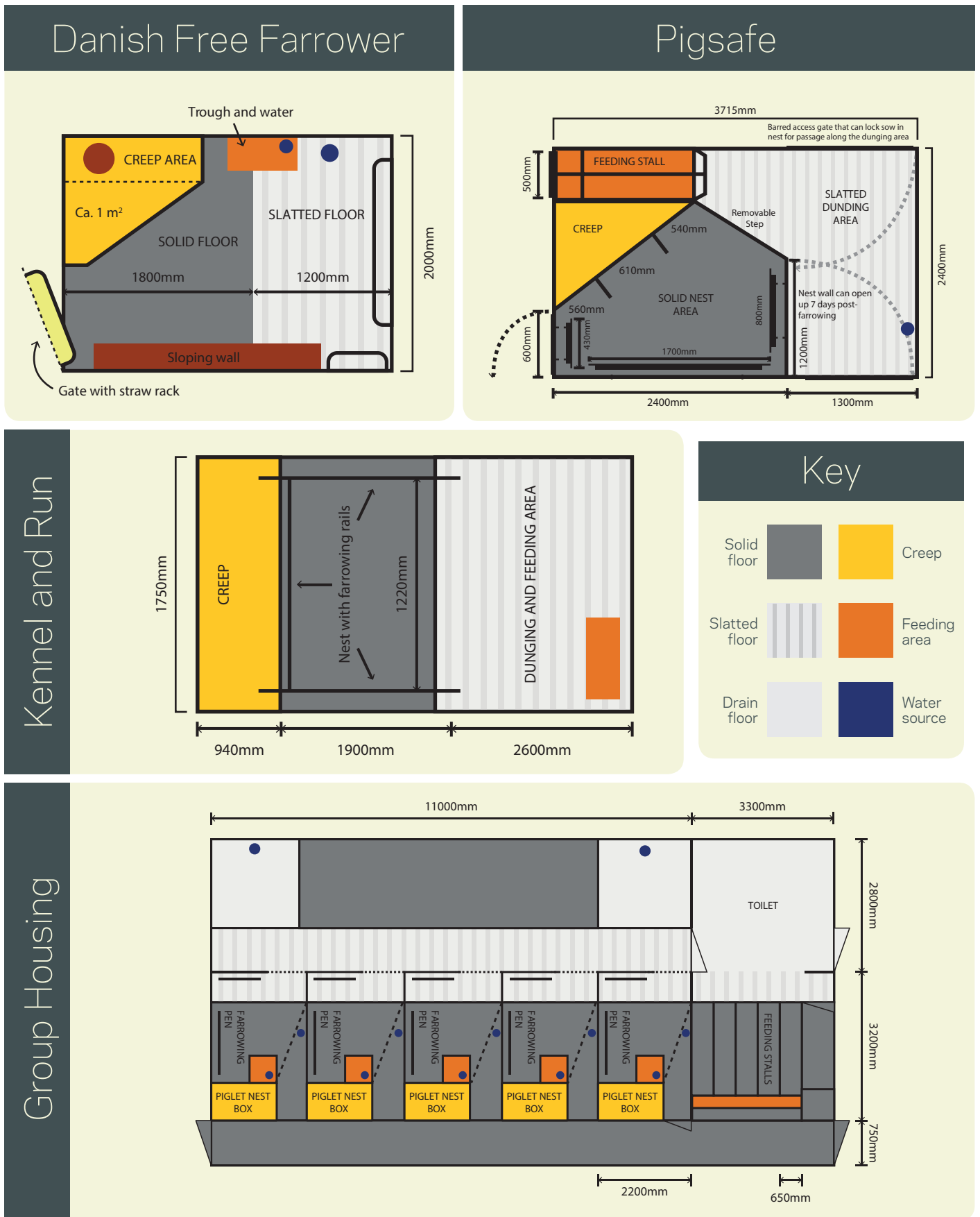


Figure 2: Designs modified from those created by pig welfare scientist Dr Emma Baxter at [www.FreeFarrowing.org](http://www.FreeFarrowing.org)

# Piglet Mortality in Different Systems

Compared to loose housing systems, farrowing crates require less space and are easier to manage, particularly with respect to manure removal and animal handling (Blackshaw *et al.*, 1994; Barnett *et al.*, 2001; Baxter *et al.*, 2012; Hales *et al.*, 2013). These confer economic and practical benefits. However, the main justification for the use of farrowing crates is decreased piglet mortality during the pre-weaning period.

Pre-weaning mortality is not necessarily decreased in farrowing crates. In fact, there is considerable variability in performance results amongst different systems, with some non-crate systems showing high piglet mortality, others on a par with crates, and some actually showing lower piglet mortality levels than crates. For example, higher piglet mortality from birth to weaning in pen-based versus crate-based farrowing systems was reported by Cronin and Smith (1992); Blackshaw *et al.*, (1994); Marchant *et al.*, (2000) and Hales *et al.*, (2014). On the other hand, Weber *et al.* (2007); Pedersen *et al.* (2011) and KilBride *et al.* (2012) did not find a difference in piglet mortality from birth to weaning between farrowing pens and crates.

However, many studies examine relatively few farms. All other factors being equal, the most reliable results will stem from the largest studies. Perhaps the largest dataset comes from Switzerland, where farrowing crates have been banned since 1997, with a 10-year transition period. This provided a very large number of farms available for study in a single country, where many other factors can be expected to be reasonably constant.

Weber *et al.* (2007) conducted one of the largest studies of Swiss farms. They found that in 2002 and 2003, the average total piglet mortality after birth on 173 farms ( $n = 18,824$  litters) with loose farrowing systems amounted

to 1.40 piglets per litter. This did not significantly differ from that of 482 farms ( $n = 44,837$  litters) using farrowing crates, where average total mortality after birth was 1.42 piglets per litter. The average litter size at birth was 11.0 in both systems, giving pre-weaning mortality rates of 12.7% (loose housed) and 12.9% (crates). Both of these were superior to the New Zealand industry average of 13.5% (Welch, 2012).

However, some other differences were detected by Weber *et al.* (2007). The number of crushed piglets was significantly higher in pens with loose housed sows (0.62 versus 0.52 piglets per litter), whereas the number of piglets that died for other reasons was significantly higher in crates (0.89 versus 0.78 piglets per litter). Total piglet mortality was influenced by both litter size at birth and the age of the sow and season - but litter size at birth remained the main influence.

So, farrowing crates do not necessarily decrease pre-weaning mortality rates. In fact, some studies have shown that farrowing crates actually increase pre-weaning mortality. Part of the reason for this may be that crated sows reportedly have decreased blood oxytocin levels (Verhovsek *et al.*, 2007; Oliviero *et al.*, 2010). This hormone stimulates the birthing process, and so a decrease in oxytocin can prolong farrowing duration. Several studies have also reported a correlation between prolonged farrowings and an increase in stillborn piglets (Fraser *et al.*, 1997; Borges *et al.*, 2005; Canario *et al.*, 2006). And indeed, Cronin *et al.* (1996) and Oliviero *et al.* (2010) observed more stillborn piglets among sows in farrowing crates, compared with those that were loose-housed during farrowing. On the other hand, Cronin *et al.* (2000), Weber *et al.* (2007), Pedersen *et al.* (2011b) and Moustsen *et al.* (2013) failed to detect such a difference.

# Causes of Piglet Mortality

Accordingly, closer consideration of what causes pre-weaning mortality is warranted. Regardless of which farrowing system is used, most deaths occur during the first 72 hours of life, either from crushing (overlying or trampling), hypothermia or starvation, or a combination of both (FAWC, 2015). Additional causes of pre-weaning mortality include savaging by the sow, and disease. A significant proportion of piglets are also stillborn. These causes of mortality were summarised by Pedersen *et al.* (2013).

## Hypothermia and starvation

New-born piglets are challenged by limited thermoregulatory capacity (e.g. a higher surface area to volume ratio than the sow), a thermal environment chosen by and for the comfort of the sow (at least, in nature), limited energy reserves (which are also needed to maintain bodily warmth), and competition for nutrition (which is increasingly problematic as litter sizes, and competition for teats, increase). Farmers normally provide 'creep' areas slightly removed from the sow, which provide protection not only from sow crushing, but also an artificial source of warmth. Despite this, hypothermia and starvation remain serious concerns, causing death in a significant proportion of piglets.

These factors also weaken piglets, making them slower to respond to dangerous bodily movements by the sow, and compromising their fledgling immune systems. Hypothermia two hours after birth was considered a significant risk factor in piglets recorded as dying from crushing, starvation, and diseases, both in crates and indoor pens (Pedersen *et al.*, 2011b; Tuchscherer *et al.*, 2000), as well as in outdoor systems (Baxter *et al.*, 2009).

## Crushing

Crushing is described by Pedersen *et al.* (2013) as the second largest contributor to mortality in both farrowing crates and pens. Pedersen *et al.* (2011b) found in a study of dead piglets from 103 gilts (crated sows n=57, loose sows n=46), that 5.8% of the live-born piglets died from crushing.

As noted previously, in their very large scale Swiss study, Weber *et al.* (2007) found 0.62 piglets per litter were crushed by loose housed sows, whereas 0.52 per litter were crushed by crated sows. Similar results were found by KilBride *et al.* (2012), who reported mortality rates of 4.6% in crates, versus 6.0% for loose housed sows. In contrast, more piglets died from other causes in crates (6.7%) vs. loose housed (4.4%).

However, these categorisations were made by farmers, and were not necessarily always correct. As noted, piglets who are weak and hypothermic are less able to respond to sow movements, and are hence more likely to be crushed. Additionally, piglets who have already died of starvation and/or hypothermia are sometimes subsequently overlain by the sow, and may be incorrectly categorised as being crushed. Hence, the true number of piglets killed by crushing is probably overestimated, and the number killed by starvation/hypothermia, probably underestimated.

## Savaging by the sow

Savaging occurs when sows attack and kill piglets. This occurs with both gilts and older sows, and is characterized by general agitation during birth (Ahlstrom *et al.*, 2002; Chen *et al.*, 2008). However, it tends to be more common in gilts than older sows (Chen *et al.*, 2008; Harris and Gonyou, 2003; Marchant Forde, 2002).

It is reasonable to expect that agitation might worsen when physical confinement and lack of nesting material prevent the sow from fulfilling her highly motivated natural urge to build a nest, and impede her ability to seek a comfortable position. To facilitate cleaning, hard surfaces such as concrete are normally used in farrowing crates.

However, studies on this point remain inconclusive. Jarvis *et al.* (2004) found increased savaging in crated sows compared to loose housed sows, Pedersen *et al.* (2011b) found no difference between the systems, and Marchant Forde (2002) found more savaging in pens compared to crates.

## Disease

Piglets are susceptible to multiple infectious and non-infectious diseases, with risk depending on the presence of pathogens, vectors and other disease-causing agents, and the immunocompetence of individual piglets. The former are affected by factors such as disease prevalence in an area and farm hygiene, and the latter by factors such as colostrum intake, hypothermia and nutrition. Although farrowing crates are sometimes claimed to be more hygienic, with easier management of urine and faeces, studies are yet to establish differing health risks due to diseases between crates and pens (Pedersen *et al.*, 2013: 100).

# Minimising Piglet Mortality

Piglet deaths within farrowing crates are far from inevitable. As Wechsler and Weber (2007: 295) assert, "Taking scientific evidence as well as practical experience into account, we conclude that piglet mortality in loose farrowing systems need not exceed that of crate systems." There are numerous more humane strategies that can and should be pursued, to minimise piglet mortality.

## Sow and piglet behaviour

As described by Wechsler and Weber (2007), both sow and piglets seem to have evolved multiple behavioural mechanisms which decrease piglet crushing risks. Upon entering the nest site, the sow will typically root in the nesting material and make snout contact with one or more piglets. This may serve to make her and the piglets aware of one another. Her lying down behaviour then consists of a sequence of controlled events. She begins by standing on the carpals of one

or both forelegs, with her hindquarters in the standing position. At this point, the piglets normally respond by grouping themselves on one side of the sow. The sow will then lie down with her hindquarters opposite to the piglet group.

If, despite all of this, a piglet has strayed too close and is at risk of being crushed, it will normally react with a reflex-like jump to the side on contacting the sow. If this fails and a piglet is trapped and wholly or partially covered by the sows' body, it will fiercely attempt to free itself, and will vocalise intensely.

In response to such piglet movements and screams (or playbacks of piglet distress calls (Cronin and Cropley, 1991; Hutson *et al.*, 1992)), the sow will usually shift from a lying position to a sitting or standing position, thus enabling the piglet to remove itself from danger.



These natural behaviours are consistent with those observed within loose housing systems. Blackshaw and Hagelsø (1990) reported that such sows rooted vigorously before lying down, and then lay down carefully, for the first eight days after parturition.

In contrast, Marchant *et al.* (2000) observed that dangerous lying-down movements of the sow were more likely to occur when the sow lay down without carrying out much piglet-directed pre-lying behaviour. They concluded that coordination of behaviour between sow and piglets is vital to reduce crushing risks.

The frequency of hazardous movements may vary significantly between sows. Spinka *et al.* (2000) concluded that sow “calmness” (including low frequency of major posture changes and cautious lying-down behaviour) and “protectiveness” (including high reactivity to recorded piglet distress calls), were two of the three factors explaining much of the observed variability in sow behaviour. Andersen *et al.* (2005) similarly reported that sows who had not crushed any of their piglets had a more protective mothering style, and responded sooner to piglet distress calls than sows who had crushed two or more of their piglets. Finally, Thodberg *et al.* (2002) observed a high level of repetition of hazardous behaviours within individual sows.

Accordingly, as suggested by Grandinson (2005), it should be possible to select for sows with low levels of hazardous behaviours, for example, by ascertaining sow responsiveness to recorded piglet distress calls when the sow is lying down. This could be highly effective, as the probability of a piglet dying is strongly related to the length of time it is trapped under the sow (Weary *et al.*, 1996a), and large individual differences in the responsiveness of sows to these piglet distress calls (Hutson *et al.*, 1991, 1993).

## Pen design

Group housing during farrowing has been linked with increased piglet mortality. Hence sows should not be group-housed during farrowing, but should be kept individually in sufficiently large pens designed to include nest and activity areas (Wechsler and Weber, 2007). Provision of sufficient space is important to facilitate protective behaviour. Damm *et al.* (2005) concluded that providing space for pre-lying behaviour and a well-controlled lying-down sequence is likely to improve piglet survival in loose housing systems.

The facilities provided within that space may also be important. European Commission Directive 2001/93/EC requires that “farrowing pens where sows are kept loose must have some means of protecting the piglets, such as farrowing rails”. Some studies show this decreases piglet mortality (e.g. Tajet *et al.*, 2003); however, others do not (e.g. Weber *et al.*, 2006).

Environmental enrichment around the birthing period can also positively affect sow behaviour, and can reduce piglet crushing. Herskin *et al.* (1998) observed that sows housed in loose farrowing pens were less likely to crush piglets when they had access to a sand floor and/or a straw feeder. Adequate provision of nest building material in the pre-birthing period can positively influence maternal behaviour, decreasing crushing risks (Wechsler and Weber, 2007), perhaps because sows that are less frustrated and more comfortable are less inclined to move around. However, enrichment may also encourage more appropriate movements. A higher proportion of sows with access to both straw and a sand floor responded by standing up during the playback of a piglet distress call.

Flooring can also be important. In many of the loose farrowing systems presently used, the floor is sloped up to 5% from the horizontal, to ensure that liquid flows off, facilitating cleaning and excrement run-off. This may also aid in piglet survival. McGlone and Morrow-Tesch (1990) found that a loose farrowing system floor with an 8% slope decreased piglet crushing, and hypothesised that this could be due to improvements in sow resting posture.

Flooring may also be slatted rather than solid, again to facilitate cleaning. Rantzer and Svendsen (2001) investigated the effect of slatted versus solid floors in the dung area of loose farrowing pens. Hygiene was better in the slatted floor pens and piglet mortality was significantly reduced, primarily due to decreased losses from infectious causes, and decreased traumatic injuries.

Given the vulnerability of newborn piglets to hypothermia, underfloor heating can also significantly aid survival. Malmkvist *et al.* (2006) found that piglet mortality was significantly reduced in a loose farrowing system that utilised underfloor heating from 12 hours prior to the onset of nest building, until 48 hours after the birth of the first piglet.

### **Additional piglet and sow factors**

Multiple additional characteristics of piglets and sows significantly increase pre-weaning mortality risks, and some of these may be amenable to intervention.

Piglets that are smaller than average, or suffering from hypothermia, malnutrition, disease or malformation, may also be weaker or have a reduced ability to react to sow bodily movements, and therefore have a higher risk of being crushed (Svendsen *et al.*, 1986; Fraser, 1990; Marchant *et al.*, 2000; Edwards, 2002). Some of these factors are related.

Lightweight piglets, for example, are more vulnerable to hypothermia, which can decrease activity levels, increasing risks of crushing, and also starvation, given competition for teats (Hoy *et al.*, 1995; Edwards 2002).

More piglets tend to be crushed in larger litters (Weary *et al.*, 1998; Jarvis *et al.*, 2005; Weber *et al.*, 2007). This may be due to higher variation of piglet birthweights in larger litters (Quiniou *et al.*, 2002), which is associated with increased mortality (Marchant *et al.*, 2000). Larger litters also increase the probability that some piglets may not gather with the rest of the litter, before the sow lies down.

Sow body condition and health status is also important. Larger sows with greater numbers of previous litters also seem more likely to crush piglets, both in farrowing crates (Kunz and Ernst, 1987) and in loose farrowing systems (Weary *et al.*, 1998; Weber *et al.*, 2007). Heavy sows with decreased fitness following prolonged close confinement (e.g. in crates) or decreased leg health (which may be exacerbated by hard surfaces) may also have difficulty lying down carefully.

As noted by Weary *et al.* (1996b), sow illness may affect her response to trapped piglets' distress calls, and, if accompanied by reduced milk production, could induce piglets to spend more time in the high-risk area near the sow. Any resultant malnutrition could weaken piglets, further increasing crushing risks.

Hence, as well as selecting for protective sow behaviours, genetic selection for smaller sows, healthier sows, and smaller litter sizes, are all likely to positively impact crushing rates. As is attention to important management factors such as hygiene, nutrition, vaccinations, minimising physical and social stressors, and provision of adequate nest-building material and environmental enrichment – all of which

may also impact sow physical and psychological health. Indeed, studies have indicated that sow characteristics such as body length, genetics and number of previous births, farm husbandry standards, and other environmental factors, may be more important than housing system alone in determining sow and piglet behaviour, and piglet survival (Weschler and Weber, 2007). Similarly, Chidgey *et al.* (n.d.) notes that, "The design of the system may not be as consequential to productivity as the management and overall husbandry". Productivity is negatively impacted by piglet mortality.

### Temporary confinement

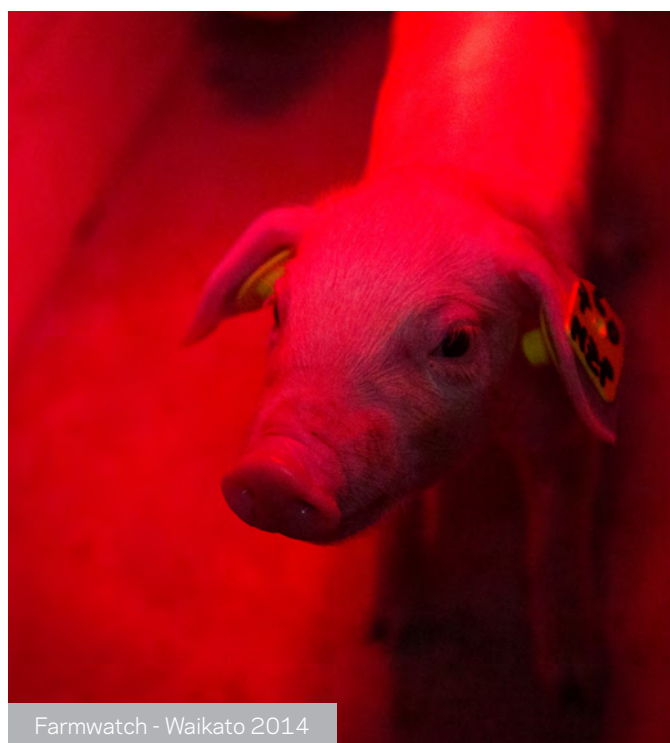
Attention to such factors has the potential to decrease piglet mortality within non-crate systems, to a level equal or superior to that achieved by farrowing crates. Even when crates are used, however, there is inadequate justification for allowing their use for the five days prior to birth plus four weeks after birth routinely allowed by New Zealand's Code.

The majority of piglets that die during pre-weaning do so within the first day following birth (Holyoake *et al.*, 1995; Marchant *et al.*, 2000), mainly because of crushing and starvation (Dyck and Swierstra, 1987; Pedersen *et al.*, 2006). A study by Marchant *et al.* (2000) and KilBride *et al.* (2012) similarly concluded that the majority of piglets that do not survive to weaning die within the first three days of life. Chidgey *et al.* (n.d.) also found that 70% of pre-weaning piglet mortality occurs within three days of farrowing. Accordingly, confining sows in crates beyond three days after birth is unlikely to protect the majority of piglets killed.

Singh *et al.* (2017) examined 672 sows and their litters over a 12-month period. No difference in piglet mortality was found whether loose housed sows were temporarily confined during farrowing and for three

days postpartum, or whether they remained in crates throughout lactation. These results are supported by other studies that examined temporary confinement of gilts (Lambertz *et al.*, 2015) and sows (Hales *et al.*, 2015; Condous *et al.*, 2016) during the birthing period and up until their piglets were 3-7 days old. Moustsen *et al.* (2013), for example, found that confinement of the sow for four days was sufficient to decrease pre-weaning mortality – and that longer confinement did not provide any additional benefit.

Thus, as concluded by Singh *et al.* (2017), piglet mortality in lactation pens with increased floor space appears to be, at the very least, similar to that when sows are confined in farrowing crates, as long as loose-housed sows are temporarily confined for three to four days following birth. They further noted that "loose-sow housing, with increased floor space and greater opportunity for interaction between sows and piglets from days 3 to 28 of lactation, may result in improved maternal behaviour in sows and improved social behaviour in piglets, without increasing piglet mortality in this period."



Farmwatch - Waikato 2014

# New Zealand Legislation and Policy

New Zealand's regulatory framework intended to protect animal welfare consists of several elements, each with different roles. In keeping with increasing national and international concern for animal welfare, and consistent with similar legislative reforms in other countries, the Act was amended in 2015 to specifically "recognise that animals are sentient" (Robertson, 2015). The Act imposes obligations on every person who owns or is in charge of an animal. This is specifically defined in Clause 4(c) as including the "opportunity to display normal patterns of behaviour".

Additional clauses of the Act reinforce these requirements. E.g. Clause 10 requires that:

"The owner of an animal, and every person in charge of an animal, must ensure that the physical, health, and behavioural needs of the animal are met in a manner that is in accordance with both —

- (a) good practice; and
- (b) scientific knowledge."

This is quite unambiguous. However, the Act does not provide further details such as minimum standards or recommendations concerning the care of animals. Instead, these are found within New Zealand's Codes of Welfare. Part five of the Act allows such Codes to be created directly by, or with oversight from, the NAWAC. These Codes are not legally enforceable in and of themselves, but violation of minimum standards specified by these Codes may be used to support prosecutions under the Act. The Code (NAWAC, 2010) provides such minimum acceptable standards, recommended best practice standards, and additional details for farmed pigs.

However, the 2015 Amendment to the Act gave the Ministry for Primary Industries (MPI) the ability to create animal welfare regulations. Unlike the Codes of Welfare, these are and will be legally enforceable. A large number of regulations have since been proposed, including 91 in 2016, and 46 in 2017. Others will be forthcoming (MPI, 2018). Some of these relate to the keeping of pigs.

Unfortunately however, the existing Act, Code and proposed regulations fall well short of the standards necessary to adequately protect the welfare of sows confined within farrowing crates, in multiple important respects.

## Space

As discussed previously, the space required to allow a sow to fulfil all of her important behavioural needs is significantly greater than the static space occupied by her own body. However, the Code merely insists that:

"When standing in a farrowing crate the sow must not touch both sides of the crate simultaneously, and her back must not touch any bars along the top." (NAWAC, 2010: 19).

A new MPI regulation (no. 27. Pigs – Size of farrowing crates) (MPI, n.d.a), scheduled for implementation on 1 October 2018, is not that much better:

"The owner or person in charge of a sow must not keep it in a farrowing crate where the sow cannot avoid touching both sides of the crate simultaneously, or touching the front and the back of the crate simultaneously, or touching the top of the crate when standing."



There is no requirement for the provision of the dynamic space required in order for the sow to be able to move – especially without injuring herself on the bars of her cage; let alone for the space and substrates that would be required to fulfil highly-motivated natural behaviours such as rooting, foraging and nest-building.

### **Environmental enrichment**

The Code (NAWAC 2010: 18) states that:

“Environmental enrichment should be provided for housed pigs. Such practices may include: the provision of “toys” such as a length of hanging chain, rock, tyre, buoy or “football” ...”

However, as mentioned previously, preference tests have indicated that pigs value indestructible materials like many of those listed above much less than they value straw. They prefer peat, compost, green branches and various wood chips, all of which are valued above straw (Pedersen *et al.*, 2005; Studnitz *et al.*, 2007).

Sows housed in farrowing systems constructed after 03 December, 2010 must be provided with material that can be manipulated until farrowing (NAWAC, 2010: 19), however there are no requirements specified concerning the quantity or nature of that material.

A number of new animal welfare regulations proposed by the MPI were not further progressed.

One of the regulations was entitled ‘Pigs – Nesting material’ (MPI, n.d.b). The reason for declining to progress this proposal to provide sufficient nesting material was given as:

“The suggested use of straw from the Pigs Code of Welfare 2010 presented significant compliance

issues for the industry in slatted systems, particularly around animal hygiene and labour. The existing minimum standard is currently not being met in a meaningful way by industry ...”

The current failure by industry to meet this existing minimum requirement in any meaningful way is occurring primarily because the provision of straw, or other manipulable material clogs drains, and increases labour requirements, and hence, production costs.

### **Crated duration**

Although the Code recommends sows be confined in farrowing crates for a maximum of 10 days, this is not a required minimum standard, and hence, is unenforceable (NAWAC, 2010: 20). Instead, the minimum acceptable standard allows sows to be confined from five days prior to farrowing, until four weeks after farrowing. Additionally, 5% of sows may be confined for an additional week for fostering purposes (NAWAC, 2010: 19).

These periods are clearly excessive. As described previously, close confinement within farrowing crates for any significant time prevents the fulfilment of a range of highly motivated behavioural needs for the sow, and most piglet mortality from overlying occurs within the first few days after farrowing. There is no justification for prolonged periods of confinement within highly restrictive farrowing crates.

### **Code violation of the Act**

The NAWAC “considers that the confining of sows in farrowing crates for extended periods does not fully meet the obligations of the Act.” (NAWAC, 2010: 19).

This is indeed true. However, NAWAC justifies this violation on the basis that:

*“Section 73(3) of the Animal Welfare Act 1999 provides that the National Animal Welfare Advisory Committee (NAWAC) may, in exceptional circumstances, recommend minimum standards that do not fully meet the obligations to ensure that the physical, health and behavioural needs of the animal are met. In making this recommendation NAWAC must have regard to, among other things, the feasibility and practicality of effecting a transition from current practices and any adverse effects that may result from such a transition, and the economic effects of any transition from current practices to new practices.”*

Section 73(3) of the Act does indeed allow the “National Animal Welfare Advisory Committee [to] take into account practicality and economic impact, if relevant” when creating Codes of Welfare.

However, this is not a licence to deviate from the stated purposes of the Act, and Codes must still comply with those purposes. E.g., Clause 73(1) states:

The National Animal Welfare Advisory Committee must, in considering the content of a draft code of welfare, and before deciding whether to recommend to the Minister the issue of that code, —

- (a) be satisfied that the proposed standards are the minimum necessary to ensure that the purposes of this Act will be met;

Other clauses (e.g. 71(1)) reinforce this.

The purposes of the Act are quite clearly stated as being to ensure that the physical, health, and behavioural needs of protected animals are met, in accordance with scientific knowledge and good practice (e.g. Clause 10 above).

With respect to farrowing crates, it is clear that alternative housing systems do exist, and can be practically and readily implemented. Indeed, these have already been implemented on a large number of pig farms within New Zealand and abroad.

Hence, by allowing the ongoing use of farrowing crates, and particularly for prolonged periods of time, the NAWAC has misused clause 73(3) to violate both the letter and spirit of the Act, because the NAWAC considers that complying with the Act will result in adverse economic effects or practical difficulties.

In fact, by allowing the ongoing use of sow farrowing crates for extended periods of time within the Code, the NAWAC has profoundly failed in its duty to safeguard the welfare of New Zealand’s sows.

Such violation of the letter and spirit of the Act is not only contrary to the best animal welfare science and to best practice, but is also clearly contrary to the wishes of a large proportion of the New Zealand public. In March 2018, a petition calling for a ban on farrowing crates signed by over 110,000 people was delivered to New Zealand’s government.

### **International precedents**

Precedent for the banning of farrowing crates already exists internationally. Their use has effectively been banned in several countries due to animal welfare concerns. Sweden prohibits the use of conventional farrowing crate systems. Sow freedom of movement may only be restricted if the sow displays aggressive or abnormal behaviour constituting an apparent risk of injury to the piglets, and only during the piglets’ first few days of life (Yngvesson personal communication 2006 in Wechsler and Weber, 2007). Farrowing crates are similarly banned in Norway, although particularly restless sows may be confined for a maximum of seven days after farrowing (Bøe personal

communication 2006, in Wechsler and Weber, 2007). In Switzerland, farrowing pens must be designed to provide sufficient space for the sow to turn around freely. Only in exceptional cases (e.g. leg weakness or the savaging of piglets) may the sow be confined to a crate while giving birth (Wechsler and Weber, 2007). Concerns about animal welfare continue to increase within both New Zealand and European nations, and Lambertz *et al.* (2015: 1374) speculated that, “A general ban of farrowing crates by European Union legislation in the near future seems to be feasible.”

Farrowing crates are also prohibited under regulations governing organic production. The European Union Council Regulation 1804/1999 on organic production of agricultural products states that “housing conditions for livestock must meet the livestock’s biological and ethological needs (e.g. behavioural needs as regards appropriate freedom of movement and comfort)” and that “all mammals must have access to pasturage or an open-air exercise area or an open-air run”. Clearly such requirements are incompatible with the use of farrowing crates (Wechsler and Weber, 2007).

### **Economic considerations**

The major reason for keeping lactating sows in farrowing crates in intensive production is to avoid crushing of the piglets. Compared to loose housing, these systems also require less space and are easier to manage, with respect to animal handling and effluent removal (Blackshaw *et al.*, 1994; Barnett *et al.*, 2001; Baxter *et al.*, 2012; Hales *et al.*, 2013). All of these factors have the potential to confer economic benefits.

However, multiple studies have demonstrated the economic feasibility of loose housing sows during the lactation period, with piglet mortality and weight gain not differing from crating systems (e.g. Cronin *et al.*, 2000; Marchant *et al.*, 2000; Moustsen and Poulsen, 2004; Pedersen *et al.*, 2011a; Moustsen *et al.*, 2013).

With the implementation of the strategies previously discussed for minimising piglet mortality, non-crate systems can offer productivity equal or superior to that offered by farrowing crate systems. This was demonstrated by the economic modelling of Ahmadi *et al.* (2011), who demonstrated higher net margins in farrowing pens designed to incorporate such features.



Farmwatch - Waikato 2017

# Conclusions

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As mentioned previously, around 60% of all pork production units in New Zealand use farrowing crates (Welch, 2012), and there were 24,300 breeding sows (aged one or over) in New Zealand by 30 June 2016. Hence, around 14,580 New Zealand sows are confined within farrowing crates.

The behavioural deprivations endured by these animals are well understood. Confined within spaces barely larger than their own bodies with minimal amounts of straw, if any, sows are unable to forage, root within natural substrate to any meaningful degree, engage in normal social interactions, or fulfil their highly motivated natural instinct to build a nest prior to giving birth. New Zealand's Code allows 95% of these pigs to be confined like this for almost five weeks continuously, and the remaining 5% to be confined for almost six weeks.

The major reason given for confining sows in this way is to decrease piglet mortality. Numerous studies of piglet mortality exist. Jointly, these do not prove that piglet mortality is necessarily improved by farrowing crates. Indeed, some of the largest studies to date (e.g. Weber, 2007) show no significant differences in piglet mortality between sows loose housed, or those confined in crates.

What is clear from these studies is that numerous management factors and sow characteristics have the potential to improve piglet mortality. They include space and environmental enrichment (which may allow and stimulate protective sow behaviours and decrease hazardous behaviours), the use of comfortable, hygienic and temporarily heated flooring, and the selection for sows with

greater responsiveness to piglet distress calls. Multiple investigators have concluded that these factors have a greater impact on piglet mortality, than housing design.

It is not necessarily the case that such superior housing and management is economically infeasible, as it is sometimes presumed. Economic modelling and multiple studies (e.g. Ahmadi *et al.*, 2011), often show the contrary, due to economic benefits associated with decreased piglet mortality, and the greater biological fitness that accrues when animals are able to fulfil their highly-motivated behavioural needs (Hamilton, 1964a and 1964b).

Several other nations have already banned the use of sow farrowing crates. If New Zealand wishes to be recognised as a nation with high animal welfare standards, and to reap the benefits this brings in terms of positively differentiating New Zealand pork to foreign and domestic consumers increasingly concerned about animal welfare, then it should join them and ban the use of farrowing crates for sows.



**112,844**

signatures in support of a ban



Norway, Sweden and Switzerland have banned farrowing crates

**14,580**

sows confined in farrowing crates



**24,000**

breeding sows in NZ (2016)



Largest study shows equal survival rate of piglets in loose housed vs crate systems



**40%**

of NZ pork production does not use farrowing crates

(Stafford, 2013)

Sows suffer stress throughout the duration of their confinement

Figure 3: New Zealand's farrowing crates: key statistics



## Recommendations

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- 1.** New Zealand's animal welfare regulations should truly reflect scientific evidence and best practice. Where reasonable doubt exists about potential animal welfare impacts on pigs, in recognition of their high degree of sentience, pigs should be given the benefit of that doubt.
- 2.** The purposes of the Act are quite clearly stated as being to ensure that the physical, health, and behavioural needs of protected animals – including pigs – are met. Codes of Welfare and MPI regulations are created under, and are subordinate to, the Act. Hence, these should also comply with these stated purposes of the Act. These purposes should not be significantly sacrificed for reasons such as economic advantage, or to cater to the preferences of some producers for certain agricultural practices.
- 3.** NAWAC recognises that "... confining of sows in farrowing crates for extended periods does not fully meet the obligations of the



- Act.” (NAWAC, 2010: 19). Accordingly, the use of farrowing crates should be prohibited under a revised version of the Code and MPI regulations. Alternate housing systems should be required, that are designed in accordance with scientific evidence and best practice, to minimise piglet mortality.
4. The space allowances provided to sows must be sufficient to allow them to exercise their full range of bodily movements, and to exercise all of their natural behaviours. This should be reflected in a revised version of the Code and MPI regulations.
  5. The manipulable materials provided to sows must also be of a sufficient nature and quantity to allow them to exercise all of the natural behaviours important to them, including nest building. In accordance with scientific evidence, materials preferred by sows must be provided, such as peat, compost, green branches and various wood chips (Pedersen *et al.*, 2005; Studnitz *et al.*, 2007). These requirements should also be reflected in a revised version of the Code and MPI regulations.



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PO Box 28110, Kelburn,  
Wellington 6150  
Ph: (+64) 04 472 9311  
[www.safe.org.nz](http://www.safe.org.nz)