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A review of aetiology and risk factors affecting sow mortality

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Sow mortality rates in the U.S. breeding herds have been increasing in recent years. Based on reports in the scientific literature, sow mortality rates started increasing by the mid- to late 1990s. This reality continues to be documented through database evaluation and reports from herd managers and producers. These trends are a clear challenge to herd veterinarians and producers in the swine industry in the U.S. and many other countries around the world. Sow mortality challenges are complex issues with multiple risk factors. This review covers reported incidences of increasing sow mortality, as well as etiologies and risk factors associated with sow mortality occurring in the modern lean-type sow. Gastro-intestinal, heart and locomotive problems, cystitispyelonephritis (inflammation of the urinary bladder and kidney), reproductive failure, prolapses, and additional disorders are consistently reported as common etiologies for sow mortality. Information on related risk factors such as population, sow housing, reproductive stage, and health status lead efforts to define and resolve sow mortality. Increasing sow mortality could well be taken as an indictment of modern production systems, of the genetically improved sows, or the knowledge and actions of animal caretakers. Prompt resolution of sow mortality is of critical importance and is a public expectation with respect to the ethical treatment and care of production food animals.

Keywords

Mortality, Natural death, Euthanasia, and Sow

Disciplines

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A review of etiology and risk factors affecting sow mortality

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Abstract

Sow mortality rates in the U.S. breeding herds have been increasing in recent years. Based on reports in the scientific literature, sow mortality rates started increasing by the mid- to late 1990s. This reality continues to be documented through database evaluation and reports from herd managers and producers. These trends are a clear challenge to herd veterinarians and producers in the swine industry in the U.S. and many other countries around the world. Sow mortality challenges are complex issues with multiple risk factors. This review covers reported incidences of increasing sow mortality, as well as etiologies and risk factors associated with sow mortality occurring in the modern lean-type sow. Gastro-intestinal, heart and locomotive problems, cystitis-pyelonephritis (inflammation of the urinary bladder and kidney), reproductive failure, prolapses, and additional disorders are consistently reported as common etiologies for sow mortality. Information on related risk factors such as population, sow housing, reproductive stage, and health status lead efforts to define and resolve sow mortality. Increasing sow mortality could well be taken as an indictment of modern production systems, of the genetically improved sows, or the knowledge and actions of animal caretakers. Prompt resolution of sow mortality is of critical importance and is a public expectation with respect to the ethical treatment and care of production food animals.

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Introduction

Sow mortality is a topic of growing interest in the swine industry as the average annualized mortality rate has increased over time [1]. Approximately 60% of sows in the U.S. commercial breeding herds are replaced annually [2]. Most sow removals from the breeding herd are involuntary, and the most commonly reported removal reasons are reproductive failure (35 to 40%), lameness and/or locomotive problems (11 to 20%), and natural death (3 to 8%) [3-6]. High sow removal rates and mortality can seriously impact the return on investments made by pork operations [7]. Additionally, annual sow mortality rate in the U.S. breeding herds have dramatically increasing from 7.9 to 10.7% between 2014 and 2017 according to PigCHAMP [1]. Sow mortality rates of 3 to 5% are generally considered acceptable in the U.S. breeding sow herds [8-10].

Mortality, decreased performance, and poor health are the main sources for economic losses in the pig industry [11]. The devastating issues are related with compromised animal welfare [12-13]. Sow mortality may be attributable to management decisions, however, the plausible reasons for increased mortality are not clear [14]. One hypothesis is that it may be difficult to adequately care for highly productive females because they have high metabolic demands to meet resulting from lactation and increasing numbers of litters and piglets per year. Secondly, producers have begun to intentionally consider the reasons for natural death and/or euthanasia, including the risk for animal welfare concerns during transport, marketing and processing. The objective of this review article is to identify etiology and risk factors influencing sow mortality.

Estimation of sow mortality

When producers record and report reasons for sow death and overall mortality rates, it is important to know whether these values including euthanized sows [15-16]. Benchmarking sow attrition should be driven by design questions rather than comparisons across herds because defining sow mortality and evaluating methods are assessed in a different manner [17-18].

Sow mortality estimates are typically reported as the mortality rate within a population and may or may not annualized. The annualized mortality rate for a specific period is reported and defined as: 100 x (number of dead sows for the period) x (365/days in the period) [19]. Mortality risk has been used as an alternative measurement for sow mortality [20]. Mortality risk can be calculated as the number of dead females divided by the number of surviving females at farrowing in each parity [20]. Some studies have reported associations between risk factors and mortality rate by utilizing simple linear models [21-23], or by combining linear models and threshold linear models [20]. Bono and coworkers [24] proposed a new model for sow mortality rates by using a dynamic generalized linear model. This proposed model utilizes new sow mortality monitoring methods and was developed in order to evaluate correlations between changes in sow and piglet mortality by parity, reproductive stage, as well as monitoring changes over time. This model could be used to develop a management tool to help the farmers monitor production, make decisions, prevent problems, and reduce economic losses [24].

Annualized sow mortality rates in many countries

Sow mortality ranged from 2.7 to 16% across countries in multiple studies (Table 1). The average annual mortality rate ranged from 4.3 to 9% from 1993 to 2016 in the U.S., 2.7 to 16% from 1978 to 2014 in some countries in Europe and 3.9 to 8.2% from 2000 to 2016 in Asian countries.

Breeding herd sow mortality etiology

Sow mortality etiology is classified into natural death and euthanasia. In previous studies [41-44], sow mortality causes were categorized by observed lesions, necropsy reports, causes, and individual risk factors. Common etiology for sow mortality from various studies are summarized in Table 2. The relative sow mortality proportions due to different etiological causes vary between studies (Table 2). Several factors responsible for the variation among herds including geographical area, environment, management practices, and population size of disease occurrence.

a. Natural death

Natural deaths in this review were observed in cases where gastro-intestinal problems, heart failure, and cystitis-pyelonephritis were observed upon necropsy in the dead sows. Natural death is a relatively common occurrence in sows [42, 49].

Gastro-intestinal problems are caused by sudden blood loss from gastric ulcers and from shock associated with gastric-, stomach- or intestinal torsion [47, 49-50]. Esophageal and stomach ulcers are common conditions in breeding herd females [49]. In other studies, sows suffering from stress-related diseases such as gastric ulcers, gastro-splenic torsions or other intestinal bleeding were associated with a pale skin color and were correlated with a pale vulva color, and an abdomen that appears to be bloated [33, 47].

Heart failure has been reported as a main cause for natural death in breeding sows, accounting for up to 31.4% [42]. D'Allaire and Droplet [51] proposed that heart failure diagnosis in breeding herd sows should be based on cutaneous cyanosis, transudate in the pericardial, thoracic, and abdominal cavities, cardiac chamber changes, pulmonary edema, and passive lung and liver congestions. Sow heart failure may be caused by a delicate cardiovascular system, low heart volume, and relatively low heart to body weight ratio enhancing sensitivity to oxygen deficiency [19, 51-52].

Cystitis (inflammation of the urinary bladder)-pyelonephritis (inflammation of the kidney) is associated with vaginitis, metritis, and a urinary tract bacterial infection [49]. This disease may cause hematuria and pyuria, anorexia, and in severe cases, acute renal failure and death [53]. Routine urination prevents infectious organisms from ascending up the urethra and into the bladder, however, if water intake is restricted and urination reduced, ascending infections may occur [49]. Affected sows may demonstrate minimal or subtle clinical signs as frequent urination in combination with weight loss and anorexia [51]. In severe acute cases, blood or discharge can be detected in the urine, and sows are found dead before expressing mild clinical signs [42].

b. Euthanasia

Euthanasia may represent large proportions of mortality losses in some herds because variation of euthanasia cases can be attributed to differences in health, management, nutrition, environment, and culling policies [51]. Euthanasia is commonly utilized for breeding sows expressing morbidity or afflicted with reproductive failure, locomotor problems, rectal and uterine prolapses. Many producers often elect to euthanize these animals, especially, when there is very little expectation that treatment of these animals would be successful within a reasonable amount of time. In practice, these causes including cystitis-pyelonephritis and/or respiratory, prolapse, and circulatory problems are identified as courses for both natural death and euthanasia.

Reproductive failures in this review are defined as observed prolonged returns to estrus, repeated negative pregnancy diagnosis and farrowing failure, endometritis, enteropathy, dystocia and retained fetuses, and uterine rupture. Parturition is a vulnerable period for the sow and vaginal and/or uterine infections can occur at this time, particularly if the farrowing was difficult [41]. Additionally, Chagnon, Maderbacher, Duran and their coworkers [41, 54, 55] have suggested that endometritis appears to be a major cause for death among gilts and low parity sows.

Locomotive system disorder is referred to as leg weakness, arthritis, ostechondrosis, and lameness. It has been reported that sows with locomotive system disorder are commonly euthanized [30, 41-42, 44, 56-58]. Locomotion or leg related problems tend to be associated with low parity sows (average parity=2.37) [59]. According to previous studies [47-48, 60], sows euthanized due to lameness by farm personnel accounted for approximately 30 to 40% of all sow mortality reasons. Arthritis, *Arcanobacterium pyogenes* infection, has been found frequently as a cause of locomotor mortality [30, 47, 61]. Engblom and coworkers [30] reported that 35 arthritis cases or 36.4% of total sow mortality reasons were relatively low parity sows (average parity=2). Osteochondrosis has resulted from many years of selecting animals for rapid growth, large muscle mass, and efficient feed conversion [60, 62, 63]. Moreover, ostechondrosis was common among postmortem examinations of gilts/sows signifying that osteochondrosis remains a significant problem [30]. Lameness can result from various pathologies or injuries to the foot, bones, or the joints as a consequence of trauma [58, 64]. Lame sows were associated with a variety of risk factors such as genetics, body conformation, exercise levels, feed management and/or housing (especially floor condition) [64].

Uterine, rectal and vaginal prolapses in breeding sows have resulted in increased percentage of breeding herds being euthanized in the U.S. for approximately the past 5 years [65]. Additionally, sows with uterine or rectal prolapse are found dead as a result of hemorrhaging [65-66]. A prolapse occurrence is partially explained by their weak pelvic diaphragm, long and flaccid uterus, and dystocia [67]. Supakorn and coworkers [65] reviewed that prolapse incidences have been associated with phytoestrogens, mycotoxins, vitamin deficiency, sow physiology, genetics, housing, acute diarrhea, severe cough, and dystocia problems.

Respiratory disease in pigs is arguably the most important health concern for swine producers [68]. Clinical signs for respiratory diseases such as coughing and sneezing are usually not a common feature in sow breeding herds. Pneumonia is not considered a major cause for breeding herd sow mortality and represents only 3 to 10% of all sow deaths [49]. This could partly explain that pneumonia is not a frequent cause of death in multiparous sows and is more likely to affect gilts and/or low parity sows [41].

When examining mortality reasons, specifically focusing on the old sows, a few sows die with heat stress, and some sows show signs of a heart condition or erysipelas, abdominal organ torsion, cystitis, vaginal and uterine prolapses, and urinary tract and kidney diseases [41, 48, 51, 54-55, 69].

Economic loss for sow mortality

The economic losses associated with sow mortality are an area of concern, due to increased replacement costs and opportunity losses, and negatively affects employee morale [70]. Losses from mortality include the cull sow value, lost piglet production, additional cost when replacing sows that die in their early parities, and the depletion of sow herd quality due to the reduced ability to cull less productive sows [71]. Stalder and coworkers [72-73] stated that the economic loss for sow culling should consider costs of replacing a sow with a gilt that include initial cost, breeding cost, housing and feed for isolation and gilt acclimation. Abell [74] reported the average price for cull sows by weight, from 1996 to 2005, was $ 100 to 150 for 136 to 205 kg, $ 164 to 182 for 205 to 227 kg, $ 188 to 208 for 227 to 250 kg, and $ 218 to 297 for 250 to 341 kg, respectively. This demonstrates that sow mortality can negatively impact the economic returns of a sow farm. Reducing breeding herd mortality will have a positive impact on the farms economic efficiency and overall profitability.

Diagnosing risk factors for sow mortality

Risk factors for sow mortality have been widely investigated by reproduction cycle stage, removal parity, climate, herd size, etc. [20, 27, 48]. A variety of risk factors have been association with sow mortality and may contribute to increased breeding herd mortality rates in the U.S. Some of the risk factors include population size, sow housing, reproductive stage, and health status appears to have triggered a sharp rise in sow mortality.

a. Population size

Studies have reported that as breeding herds become larger, sow mortality generally increases [75-76]. Christensen [44] stated that death loss rate in the U.S. was related to breeding herd size and gilt inventory. According to the USDA in 2012 [76], sow mortality rates in the small (≤ 250 sows) population (2.5%) was lower when compared to mortality rate in medium (250 to 499 sows) (3%), and large (≥ 500 sows) populations (3.7%). According to previous studies [15, 20, 25, 27, 44], a large breeding population (≥ 500) had greater mortality risks compared to a smaller sow breeding populations (≤ 100). Alternatively, Tani and coworkers [40] reported that population size was not associated with farrowed sow mortality risk in any parity groups (P>0.05). This research was consistent with Iida and Koketsu [38] in Japan, and Jensen and coworkers [33] in Danish pig populations using similar herd size.

Increased sow mortality rates occurring in large sow populations may be likely negatively associated with caretaker experience when compared to the caretaker experience in small sow farms [60, 77-78]. Barn workers in low-performing sow herds are less likely to recognize a sow at risk and intervene with a treatment or make the decisions to cull the sow promptly [78]. Three essential skills for a being successful stockperson are good observation skills to identify sow's problems, farm management knowledge and skills to solve significant problems, and an action attitude to promptly fix the given problem [77]. However, personnel on large operations may not have enough time to focus on compromised sows showing clinical symptoms [27] and water consumption especially the increased water requirements for lactating sows [49, 79].

b. Sow housing

Sow mortality rate in breeding herds are influenced by yearly seasonal temperature fluctuation [19, 27, 40-41, 81]. In previous studies [27, 40-41], it has been reported the incidence for mortality is greater during summer months in commercial sow herds in the U.S., Canada, Spain, and Portugal. Deen [81] reported that the relative sow mortality risk approximately doubled, when the ambient temperature exceeded 32ºC. However, Iidia and Koketsu [38] reported high parity sows are more sensitive to low temperature when compared to low parity sows. The biological reasons for this difference is not clear. Some symptoms such as coughing and sneezing are related to physiological responses to cold and large variation in daily temperature [82], exposure to cold weather and indoor air pollutants [83]. In confinement operations, well-designed ventilation systems may not always be adequate to keep sows cool, especially under high humidity conditions, [19, 84, 85] while drinking water is necessary for hydration in summer [86]. In winter, the recommendations are to install thicker insulation in breeding herd housing facilities [87], and building temperatures should be maintained between 15 and 21ºC [88].

Sows housed in group-housed systems have been found to suffer from more injuries when compared to sows housed in individual gestation stalls because of aggressive interactions such as vulva biting and fighting for feed in order to establish to a new sow social hierarchy [89-91]. Vulva lesion severity has been found to increase in systems with electronic sow feeders (ESFs) and these injuries may ultimately result in greater natural death and/or euthanasia [89] when compared to other sow housing systems.

There is no clear maximum group size in loose housing. In practice, sows are maintained and housed in groups of up to 300 individuals with no obvious detrimental effect to the occurrence of social aggression [91]. Investigations on the ideal space allowance have concentrated on the consequences of different space allowances on productivity and aggression. For the production reasons, space allowances are 1.3 to 1.8 m^2 for individual stall, 2.8 m^2 for pen group, and 2.32 m^2 for ESFs pen have been recommended in the U.S. and Australia [92-93]. From a social aggression point of view, Wang et al. [94] recommended that space allowances between 2.4 to 3.6 m^2 are suitable for stable groups of 6 sows fed separately in available stalls for gestation sows.

Shape of the pen may be relevant to sow mortality. Docking and coworkers [95] reported that a circular pen with a large space allowance (9.3 m^2/sow with groups of 5 unfamiliar sows) is suitable for reducing aggressive impact. However, reports have suggested that producers should use rectangular pens at low densities to optimize the combination of escape possibilities and building cost for gestating sows [91]. Drolet and coworkers [53] reported increased cystitis-pyelonephritis cases may be caused when sows are housed in gestation stalls. Gestation stalls may predispose sows to urinary tract infections due to lack of exercise [96], and the fact that sows must lie in their own waste [56]. Jensen and coworkers [33] reported sows housed on solid floors in stalls increased mortality risk. Solid floors are more likely to be covered with feces and urine, and therefore, have a poorer hygiene and be more slippery when compared to other flooring types (e.g. slatted floors). Slippery floors may cause a greater trauma risk due to falling, explaining the increased mortality risk for pregnant sows and being associated with sow's foot and toe lesions causing feet and leg problems when sows are housed on solid floors [33, 97-989].

c. Reproduction stage

Several studies have reported similar sow mortality results in which a relatively large proportion of sows died prior to the completion of farrowing [16, 20, 30, 38, 70, 99, 100]. Mortality proportion rates for natural death and euthanasia in breeding (6 and 20%), gestation (6 and 37.5%), lactation (12 and 9.3%), and weaning to service (24%) have been reported [29-30, 59, 89]. A couple weeks prior to farrowing and the first few weeks of lactation had higher mortality rate (50%) when compared to other sow production stages [31, 38, 48, 54, 70, 99-101]. Deen and coworkers [16] reported that high sow mortality rates across the U.S. between 1996 and 1998 occurred in the first three weeks post farrowing. Sørensen and Thomsen [100] suggested that the major cause for sow mortalities in the farrowing period was metabolism disorder. Friendship and Sullivan [49] explained that high mortality rate during lactation period are possibly associated with postpartum dysgalactia syndrome.

Reducing mortality in low parity sow (≤ 3 parities) is invaluable in maintaining an optimum parity profile in herds, since improving the average culling parity will increase overall herd lifetime production, and enhance profitability. In general, a sow should achieve between 3 and 4 parities to produce enough piglets to "pay for herself" [3, 73, 102-103]. A summary of sow mortality by parity from the scientific literature is presented in Table 3. Summarizing the results reported in the literature, it is suggested that the greater incidence of breeding herd mortality occurs in parity zero through parity 3. However, rapid sow mortality acceleration can occur in breeding sows that are in parity 8 or greater [68]. Tani and coworkers [9], reported the two greatest post farrowing mortality incidence rates occurred among sows in parities 6 to 7 parity (2.2 and 2.3 %). Possible reasons for the high mortality in older sows was due to stress after farrowing, more stillborn piglets, and prolonged weaning to service interval [9].

d. Health status

Loula [78] stated that diseases appeared to play a role in increased sow mortality and farms with more disease pressure had greater sow death loss without the disease being the actual mortality cause. Diseases influencing breeding herd sow mortality such as Porcine Reproductive and Respiratory Syndrome (PRRS) outbreaks significantly increase sow death loss [45].

Vaccinating breeding herd females for PRRS (PRRS killed virus) leads to significantly reduced of breeding herd deaths ($P<0.01$), and improved sow longevity 1.5 years after the vaccination started ($P<0.001$) [9, 104]. The impact of other diseases on breeding herd mortality have been reported in studies in Europe and Japan. Kiss and Bilkei [105] reported post-parturient sow losses in a large outdoor production units with suboptimal environments in Croatia caused by *Clostridium difficile*, and *Clostridium novyi* caused sudden death in Iberian gestating sows in outdoor units in Spain [106]. The *C. difficile*-related health problems may be enhanced by stress, lack of hygiene, dietary changes, and the use of certain antimicrobial types [107-109].

Conclusion

In the modern pork industry, sow mortality has become one of the primary focuses for producers and their veterinarians. Based on scientific literature reports, a major portion of natural sow deaths are caused by gastro-intestinal problems, heart failures, and cystitis-pyelonephritis. Further, the primary reasons for euthanizing breeding herd females resulted from reproductive failure, locomotor disturbances, prolapses, respiratory and circulatory disturbances. The highest sow mortality rates occur during the first three weeks after farrowing. To enhance understanding of sow mortality causes, producers should more accurately record reasons for sow mortality in both natural death and euthanasia and overall mortality rates in order to better evaluate the actual cause and develop mitigation strategies for the breeding herd mortality.

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Table 1 Summary of sow annual mortality rates from the scientific literature from 1995 to 2017.

Year	Country	Number of herds	Mortality rate (%)		Reference
			Population size (sows)	Mean	
1995	France	102	2,251	6.4	[25]
1996	U.S.	130	29,468	6.7	[26]
1993	U.S.	825	146 to 1,548	4.3	[27]
1997				5.8	
1978	Spain	335	169,780	3.3	[28]
1988				3.7	
1998				4.2	
2003				6.0	
2003	Brazil	106	1,157 to 2,028	5.5	[29]
	Canada	95	1,046 to 2,239	6.5	
	U.S.	364	1,116 to 2,190	7.8	
2006	Sweden	13	2,200	3.9[1]	[30]
				12.0[2]	
2007	U.S.	16	NR	8.9	[31]
2007	Sweden	25	122 to 2,126	4.3	[32]
2008	Denmark	34	3,652	2.9[3]	[33]
			1,266	2.7[4]	
2009	U.S.	1	2,000	9.0	[34]
2014	Finland	39	50 to 1,008	9.0	[35]
2005 to 2016	Canada, China, and U.S.	860	125 to 10,000	8.2	[36]
2000 to 2004	Japan	140	65,621	3.9	[20]
2001 to 2014	U.S.	17	105,719	8.3	[37]
2003 to 2009	Japan	98	47 to 3,447 412±55.8	8.9	[38]
2006 to 2012	Hungary	2	600 (Farm A) 700 (Farm B)	16	[39]
2011 to 2014	China	1	12,831	8.2	[5]
2008 to 2013	Spain Portugal	121	81 to 3,222 699±64.3 in Spain 592±50.3 in Portugal	14.4[5]	[40]

[1] average of sows found dead, [2] average of euthanized sows, [3] pregnant sows and [4] lactating sows, [5] This mortality rate was showed a proportion over 3 years. NR=not reported

Table 2. Etiology for sow mortality proportion rate (%) and median in sow breeding herds

	Reference/ year											Median (%)
	[41] 1991	[42] 1991	[43] 1994	[44] 1995	[45] 1999	[46] 1999	[47] 2005	[28] 2006	[48] 2007	[20] 2008	[6] 2017	
Gastro-intestinal problems[1]	18.9	20.9	68.4	21.2	-	12.9	18.5	26.6	19.6	-	5.3	19.6
Feet & leg problems	-	-	-	16.1	-	38.2	46.4	15.7	23.4	4.2	19.3	19.3
Reproductive failure	6.6	-	10.5	10.7	25.0	12.1	14.0	8.8	18.7	18.3	14.1	13.1
Inferior body condition	2.2	5.3	-	16.1	38.2	-	-	2.0	-	-	19.3	10.7
Heart failure	31.4	22.9	5.2	15.0	4.0	4.0	-	-	-	-	3.4	10.1
Prolapse	6.6	-	-	-	-	-	-	-	-	10.8	9.0	9.0
Injury, health & disease	-	16.4	2.7	-	-	-	-	-	3.7	15.1	2.0	3.7
Cystitis-pyelonephritis	8.0	7.5	2.7	15.2	2.2	2.2	3.4	9.6	11.2	-	2.1	5.5
Pneumonia	3.6	6.8	2.7	-	9.9	9.9	-	3.1	7.5	-	-	6.8
Old age	-	-	-	-	-	-	-	-	-	-	0.3	0.3
Miscellaneous	22.7	20.2	7.8	5.7	20.7	20.7	17.7	34.2	15.9	51.6	25.5	20.7

[1] Digestive problems defined as torsions/ gastrointestinal accidents and gastritis.

Table 3. Sow mortality proportion rate (%) by parity conducted from 1999 to 2017[1]

<table>
<tr><th rowspan="2">References/ year</th><th rowspan="2">Country</th><th rowspan="2">Average parity</th><th colspan="8">Mortality proportion rate (%) by parity</th></tr>
<tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>>7</th></tr>
<tr><td>[45]/1999</td><td>US</td><td>NR</td><td>10.3</td><td>22.4</td><td>15.8</td><td colspan="4">← 43.8 →</td><td>2.9</td></tr>
<tr><td>[40]/1999</td><td>US</td><td>NR</td><td>4.8</td><td>3.6</td><td>3.8</td><td>4.5</td><td>4.2</td><td>4.8</td><td>4.1</td><td>5.1</td></tr>
<tr><td>[3]/2000</td><td>US</td><td>3.2</td><td>14.2</td><td>14.1</td><td>16.1</td><td>14.4</td><td>13.6</td><td colspan="2">← 17.5 →</td><td>10.2</td></tr>
<tr><td>[28]/2006</td><td>Spain</td><td>NR</td><td>NR</td><td>35.0</td><td>27.2</td><td>13.8</td><td>7.3</td><td>5.1</td><td colspan="2">← 11.6 →</td></tr>
<tr><td>[39]/2007</td><td>Sweden</td><td>3.4</td><td>NR</td><td>16.9</td><td>13.6</td><td>11.6</td><td>11.1</td><td>10.9</td><td>9.1</td><td>26.8</td></tr>
<tr><td>[32]/2008</td><td>Japan</td><td>3.2</td><td>14.6</td><td>16.1</td><td>12.4</td><td>12.5</td><td>13.2</td><td colspan="3">← 31.3 →</td></tr>
<tr><td>[5]/2015</td><td>China</td><td>4.1</td><td>4.5</td><td>18.7</td><td>14.2</td><td>11.4</td><td>10.8</td><td>10.0</td><td>8.4</td><td>22.0</td></tr>
<tr><td>[6]/2017[2]</td><td>US</td><td>2.7</td><td>12.8</td><td>18.3</td><td>16.4</td><td>14.8</td><td>13.4</td><td>11.7</td><td>4.4</td><td>8.2</td></tr>
<tr><td>[40]/2017[3]</td><td>Spain & Portugal</td><td>3.4</td><td>3.0</td><td>13.8</td><td>10.1</td><td>11.4</td><td>12.2</td><td>1.9</td><td>19.5</td><td>16.1</td></tr>
</table>

[1] Estimates of sow mortality rate came from the scientific literature. [2] These data were from 922 farms (58,610 sows), [3] These data were modified from mortality rates for pregnant and farrowed sows. NR=Not reported