

# IDENTIFICATION OF RISK FACTORS AND STRATEGIES FOR REDUCING SOW MORTALITY

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JAN TIND SØRENSEN AND RIKKE THOMSEN

DCA REPORT NO. 097 · JUNE 2017



AARHUS  
UNIVERSITY

DCA - DANISH CENTRE FOR FOOD AND AGRICULTURE



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## Preface

During the last decade there has been a societal concern regarding sow mortality, which seems to be relatively high in Denmark compared to other countries. A declaration from the Ministry of Food, Agriculture and Fisheries in 2014 launched a plan of actions towards improved animal welfare of pigs, including an aim for reducing sow mortality. In October 2014 the Danish Veterinary and Food Administration asked Aarhus University (AU) to make a statement identifying risk factors for sow mortality. The resulting statement is based on a literature review aiming at an identification of causes of sow mortality relevant for Danish conditions and risk factors related to mortality. The review is based on national and international literature. The statement is further based on data from a Danish rendering plant and supplementary analyses on data from research studies conducted by Aarhus University. Possible solutions were synthesised and discussed at a workshop held at AU on December 8<sup>th</sup> 2015. An initial part of the literature review and supplementary data analysis was conducted by Scientific Assistant Rikke Thomsen, as employed at Aarhus University. Rikke Thomsen is now employed at Center for Development of Outdoor Production.



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## Sammendrag

En død so repræsenterer et økonomisk tab for svineproducenten, og kan være et tegn på nedsat dyrevelfærd i sobesætningen. Der er derfor, såvel i branchen som i offentligheden, et kritisk fokus på niveauet af sodødeligheden i Danmark. Landbrug og Fødevarer satte i 2008 en målsætning om at reducere sodødeligheden med 25 % fra 2008 til 2013, og satte yderligere i 2014 et mål om at reducere sodødeligheden til 9 % i 2018. Tilsvarende inkluderede politikerne i Veterinærforlig I i 2008 en målsætning om at nedbringe sodødeligheden ved at sætte grænseværdier for sodødelighed, som, hvis de blev overskredet, vil føre til skærpet overvågning af sobesætningen. Ministeriet for Landbrug, Fødevarer og Fiskeri formulerede i samarbejde med erhvervs- og dyreværnsorganisationer en handleplan, som bl.a. skulle nedbringe sodødeligheden. I den forbindelse blev der efterspurgt yderligere information om risikofaktorer. Formålet med nærværende rapport er at identificere de vigtigste risikofaktorer for sodødelighed i Danmark og videre at foreslå strategier til nedbringelse af sodødeligheden.

Resultater fra destruktionsanstalten DAKA, der modtager alle søer, der er døde i besætninger i Danmark, viser et fald fra ca. 160.000 døde søer i 2008 til 118.000 i 2015. I forhold til det totale antal søer i Danmark svarer dette til et fald i sodødeligheden fra ca. 15,1 % i 2008 til ca. 11,4 % i 2015. Sodødelighed i forskellige lande er sammenlignet baseret på publicerede videnskabelige artikler. En sammenligning med niveauet for sodødelighed rapporteret fra Sverige (7,3 %/år), Japan (8,9 %/år) og USA (9,5 %/år) viser dødeligheder, som generelt er på et lavere niveau end i Danmark.

Søer, der dør i besætningen, kan deles i to grupper, som er nogenlunde lige store; søer der er aflivet og søer, der er selvdøde. I rapporten er der gennemført et review af rapporterede studier af dødsårsager og risikofaktorer for sodødelighed. I studier, hvor svineproducenten spørges om årsagen til, at soen bliver aflivet, angives halthed/benproblemer som den dominerende årsag, efterfulgt af skader som den næsthøjest angivne årsag. Når svineproducenten spørges til årsagen til, at en so er selvdød, angives ofte, at dødsårsagen ikke kendes. De hyppigst angivne årsager til selvdøde søer er mave-/tarmproblemer, faringskomplikationer og sygdom. Ved obduktion af selvdøde søer angives mave-/tarmproblemer, hjerteproblemer samt faringsproblemer som de hyppigste årsager.

Litteraturstudiet over risikofaktorer for sodødelighed peger på varmemstress, idet der ses en overdødelighed i varme perioder. Et dansk studium peger på, at fast gulv i drægtighedsstalde samt dårlig hygiejne er faktorer, der relaterer til døde/aflivede søer. Fast gulv som en risikofaktor skyldes sandsynligvis fast gulv i kombination med dårlig hygiejne.

Resultaterne fra litteraturstudiet og de supplerende analyser blev diskuteret ved en afsluttende ekspertworkshop. Ud fra en samlet faglig vurdering kan følgende uprioriterede anbefalinger gives:

### Aflivede søer

- Da en stor del af de aflivede søer aflives pga. af halthed/benproblemer, anbefales systematisk overvågning i drægtighedsstalden, som omfatter daglig kontrol af alle søers gang.
- Der skal være systematiske strategier for håndtering af halte søer i form af kriterier for indsættelse i sygesti samt anvendelse af antibiotika og/eller smertestillende medicin.
- Der skal være fokus på sygestier, deres kvalitet og kapacitet
- Der skal etableres forbedrede procedurer for producentens egenkontrol med opfølgning af besætningsdyrlægen, der som udgangspunkt omfatter sodødelighed som fokusområde
- Systematiske strategier med entydige kriterier for aflivning skal foreligge i alle sobesætninger
- Der er behov for mere forskning i forebyggelse af halthed/benproblemer i sobesætninger samt i indretning af løbe/drægtighedsstalde

### Selvdøde søer

- Der skal indsamles systematisk information om dødstidspunkt og huld på selvdøde søer i danske sobesætninger
- Systematisk anvendelse af obduktioner skal være en integreret del af sundhedsrådgivningen i sobesætninger
- Information til producenten om fund af mavesår på slagtesøer skal gives rutinemæssigt fra slagterierne
- Systematiske planer for diagnoser og efterfølgende handling skal beskrives og vedligeholdes i alle danske sobesætninger
- Der er behov for mere forskning i årsager til selvdød med fokus på reduktion i faringsproblemer og varmebelastning under laktation



## 1. Introduction

A dead sow in the sow herd, either unassisted dead or euthanized, is a failure. It represents an economic loss for the farmer (Stein et al., 1990) and it may indicate compromised animal welfare in the sow herd (Knage-Rasmussen et al., 2015). Sow mortality in Denmark was estimated to be 11.3% in 2011 (Frandsen 2015), which was seen as an unacceptably high level by the industry as well as by society. As already as in 2008 The Parliament decided (Veterinærforlig I) to stimulate a reduction in sow mortality by making thresholds for sow mortality at herd level, and exceeding the threshold would result in increased control and extra costs for the farmer. In 2008 the industry introduced a goal of reducing sow mortality by 25 % during the period from 2008 to 2013, resulting in an 11 % mortality rate in 2013, and agreed to work for a further reduction down to 9 % in mortality in 2018. An action plan agreed between the Ministry of Agriculture, Food and Fisheries and the industry made in 2014 referred to the aim set by the industry and asked for further information on risk factors and ways to reduce sow mortality. The aim of the present report is to identify risk factors for sow mortality and to suggest strategies for reducing sow mortality. This is accomplished by making a literature review, making a pilot survey on current causes of death as a supplement, summarizing major risk factors and finally suggesting strategies to reduce sow mortality in Denmark.

## 2. Sow mortality in Denmark and in other countries

### 2.1 Development in sow mortality in Denmark

In Denmark all dead sows, either euthanized by the farmer or dying unassisted, are sent to a rendering plant called DAKA. The annual mortality rate increased from 1980/1990 until 2000/2010 (Frandsen 2015, 2016). Numbers of dead sows sent to DAKA from 2008 to 2015 are presented in Figure 1 and percentage of dead sows is presented in Figure 2 (Frandsen 2016). Calculation of percentage of dead sows is based on the number of dead sows per year divided by the mean number of sows present in one year, counted on day one in each of four quartiles throughout a year (Danmarks Statistik 2015). Both figures show a reduction of sow mortality from 2008 to 2015.

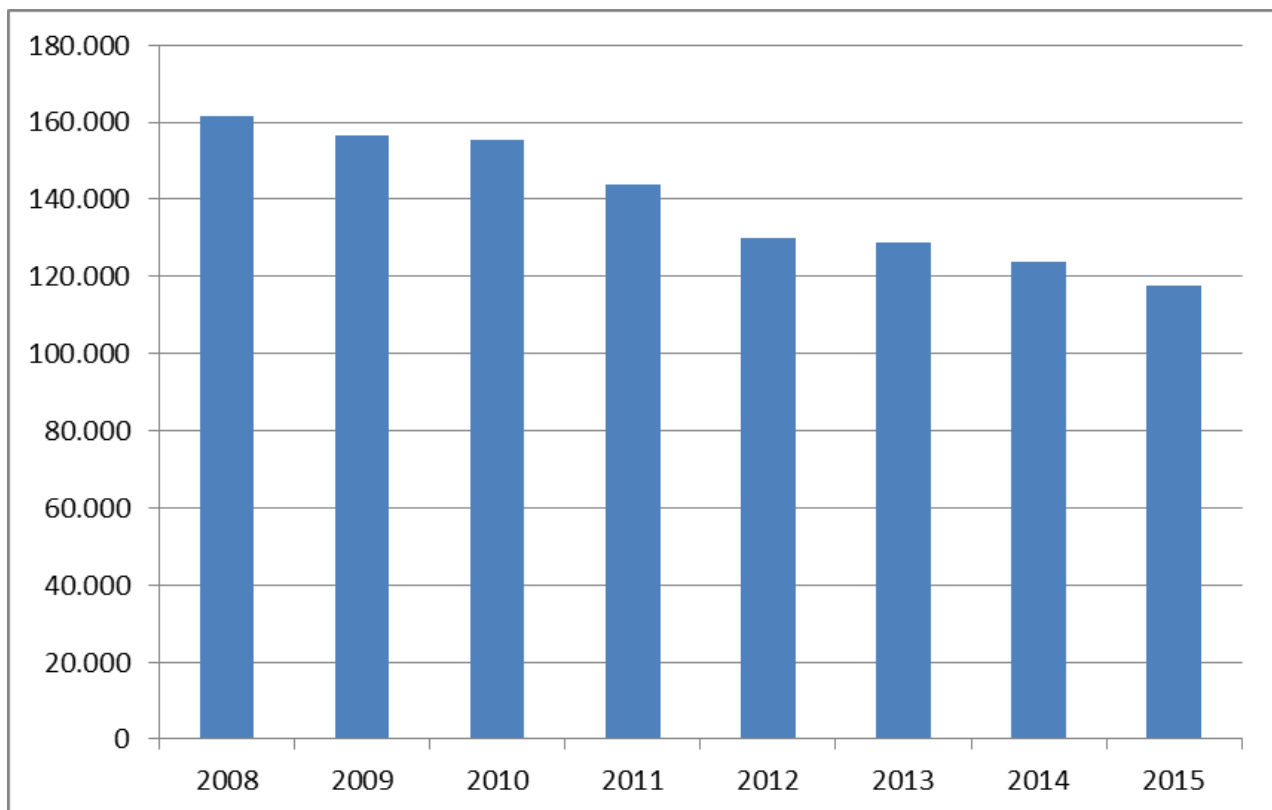


Figure 1. Number of dead sows delivered to the rendering plant DAKA each year from 2008 to 2015. The numbers include sows and gilts.

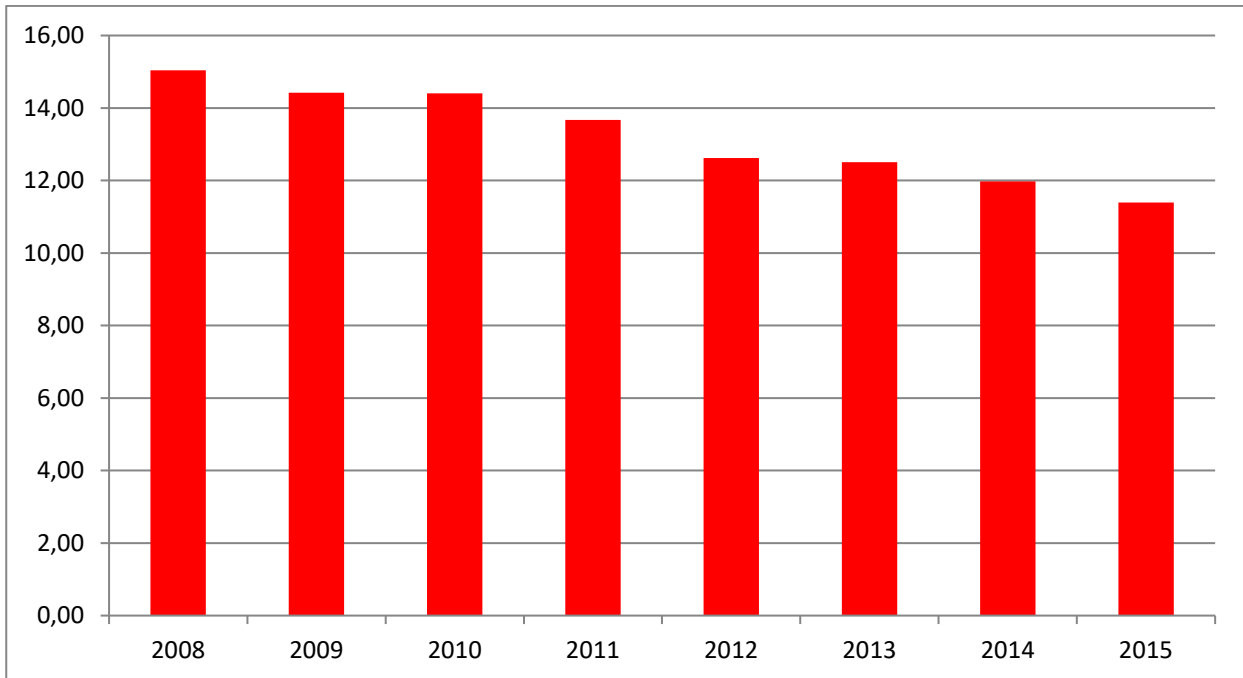


Figure 2. Percentage of dead sows per year from 2008 to 2015, calculated as the number of dead sows delivered to DAKA divided by the average number of sows in Denmark derived from Danmarks Statistisk

## 2.2 Sow mortality in Denmark compared to other countries

Sow mortality in different countries has been compared based on published scientific reports. Pedersen and Brendstrup (1998) investigated causes of sow mortality among 9000 sows from 29 herds during one year in 1997. In this study, 592 sows were registered as dead resulting in an average mortality of 8.9 % per herd. For 494 sows the cause of death was registered together with an indication of each sow being either euthanized or dying unassisted. Of these 494 sows, 42 % were euthanized and 58 % died unassisted. The average sow mortality ranged from 2.2 % to 13.1 % across the 29 herds. In a study by Vestergaard et al. (2004), investigating causes of sow mortality in Danish herds in 2003, 11 % of the culled sows in 37 herds died unassisted and 10 % of culled sows were euthanized.

In a study including 3652 pregnant sows from 36 Danish sow herds the mortality rate for a 3-month period in 2008 was 2.9 %, with 1.9 % of the sows dying unassisted and 1 % being euthanized (Jensen et al., 2012). For the 1266 lactating sows included in the study, the mortality rate during this 3-month period was 2.8 %, with 1.7 % dying unassisted and 1 % being euthanized. The 3-month mortality rates between the herds in the study by Jensen et al. (2012) ranged from 0-8 % for pregnant sows and 0-25 % for lactating sows. In a study investigating sow removal on Swedish herds the annual mortality rate was 5.2 % for sows being euthanized (2.2-10.8 %) and 2.1 % for sows found dead (0.9-4.1 %) in the period from 2002-2004 (Engblom et al., 2007).

In a study comprising 63 Danish conventional (51) and organic (12) pig herds in 2010/2011 data were obtained from the Danish rendering plant DAKA. This showed that sow mortality ranged from 5.2 % to 34.4 % between sow herds with a mean of 12.7 % per year sow (Knage-Rasmussen et al., 2015).

A study conducted in Japan reported an annual herd mortality rate of 8.9 % during a period of four years from 2003 to 2007 (Iida and Koketsu, 2014); and Sasaki and Koketsu (2008) found an annual herd mortality rate of 3.9 % for sows dying unassisted only in their investigation of mortality in 105 Japanese herds in 1999-2002. Only 0.2 % of the sows were euthanized in the Japanese study (Sasaki and Koketsu, 2008). In the US swine industry, a mean annual herd mortality rate of 9.5 % for a five-year period from 2005 to 2010 was demonstrated (Knauer et al., 2013). Somewhat lower numbers were found in USA in 1997 an annual sow mortality risk of 5.7 % reported by Koketsu (2000). A study from Québec demonstrated an average herd mortality rate of 3.3 % during one year of observation in 1987/1988 (Chagnon et al., 1991).

Table 1. Mortality of sows reported in literature

Source	Country	Annual mortality		Distribution euthanized/unassisted		N herds/animals	Study period (year)
		Mean	Herd range	Euthanized	Unassisted		
Pedersen and Brendstrup (1998)	Denmark	8.9	2.2-13.1	42	58	29/9000	1
Vestergaard et al. (2004)	Denmark			48	52	37/-	-
Jensen et al. (2012) <sup>a</sup>	Denmark			34	66	36/3652	0,3
Jensen et al. (2012) <sup>b</sup>	Denmark			37	63	36/1266	0,3
Knage-Rasmussen et al. (2015)	Denmark	12.7	5.2-34.4	-	-	36/-	1
Engblom et al. (2007)	Sweden	7.3		71	29	21/-	3
Knauer et al. (2013)	USA	9.5		-	-	-/1.8 mio/year	5
Koketsu (2000)	USA	5.7		-	-	270/'-	5
Chagnon et al. (1991)	Canada	3.3	0-9.2	-	-	24/'-	1
Iida and Koketsu. (2014)	Japan	8.9		-	-	98/93,837	4
Sasaki and Koketsu (2008)	Japan	4.1		5	95	105/6,501	3

<sup>a</sup>pregnant sows, <sup>b</sup>lactating sows,

### 3. Causes of sow death

#### 3.1 Causes reported in the literature

Cause of death can be determined through information from the farmer, which is based on an assessment performed by the farmer. Cause of death can also be determined by necropsy, which provides a more precise diagnosis of the cause of death. Studies have shown that there is often only little compliance between a farmer's assessment and a necropsy regarding the actual cause of death of a sow (Thorup et al., 2010; Vestergaard et al., 2004).

Tables 2-5 show the distribution of causes of sow death, divided into sows being euthanized or dying unassisted. In the study by Pedersen and Brendstrup (1998) the registration of cause of mortality showed that among sows dying unassisted most sows died of problems in the stomach and intestine, or it was categorized as 'other causes' (Table 2). This category included sows where it was not possible to determine the causes of death, but a small percentage of the sows in this category were believed to have died of heat shock due to a very warm summer in the year of registration, and a small percentage (app. 9 %) were believed to have died of kidney problems, demonstrated by further analysis of eye fluid from these sows. Thorup et al. (2010) found a proportion of 29.3 % with inflammation of the kidneys from histological observations of tissue from 37 farrowing sows, most of these being sows dying unassisted. However, in Thorup et al. (2010) an inflammation of the kidneys was not assumed as the primary cause of death, which was determined by necropsies (see Table 3).

In the study by Pedersen and Brendstrup (1998) the most likely cause of death for sows being euthanized was leg problems, an easy to determine diagnosis, which means that the sow cannot be transported for slaughter. Similar results were found by Vestergaard et al. (2004) in their investigation on 37 herds, with euthanasia of sows being mostly due to leg problems (56 %) and other disease (11 %). For sows dying unassisted the cause of death was either categorised as undefined disease (22 %) or no obvious cause (52 %) (Vestergaard et al. 2004) (Table 2). Leg problems were also found to be a main cause for euthanasia, when Engblom et al. (2007) investigated causes for euthanizing of sows in Swedish herds, with 24.8 % being categorized as lameness and/or foot lesions and 52.0 % categorized as traumatic injuries (see Table 4).

In the study by Vestergaard et al. (2004) necropsies were performed (for 169 euthanized sows and 94 sows dying unassisted) for a part of the dead sows registered in the study period to give a more precise cause of death compared to what was presumed by the farmers (Tables 3 and 5). The results from the necropsies show that the primary causes of euthanasia were related to the locomotor system of the sows (Table 5). Sows dying unassisted often seemed to die due to circumstances of reproduction and torsion of organs (Vestergaard et al. 2004) (Table 3).

It appears that locomotive disorders constitute a dominating factor in relation to the euthanasia of sows. A further investigation of such disorders was performed by Kirk et al. (2005) where pathological examinations of 265 sows from 10 Danish pig herds were performed. From the 72 % that were euthanized due to locomotive disorders (see Table 5), 24 % was diagnosed with arthritis and 16 % with fractures; those two being the most frequent causes of euthanasia (Kirk et al., 2005). As a secondary diagnosis, arthrosis in at least one joint was recorded in 88 % of the euthanized sows and in 92.5 % of sows dying unassisted. In addition, numerous claw lesions were found in both sow groups. Knage-Rasmussen et al. (2014) investigated the prevalence and risk factors for lameness in conventional and organic pig herds and found a mean prevalence of lameness of 24.4 % in conventional pregnant sows and 5.45 % in organic pregnant sows. Bursitis was associated with an increased risk of lameness for both conventional and organic sows. As reported above, severe lameness can lead to euthanasia of sows and less severe lameness can indirectly lead to culling, as it affects the performance of the sow (Heinonen et al., 2013).

In the study by Kirk et al. (2005), the main causes of death for sows dying unassisted were disorders of the gastrointestinal system (45 %) including torsion of liver (12 %), torsion of the spleen (9 %) and rupture of the liver, perforation of oesophagus and intestinal volvulus (11 %) and the reproductive system (24 %) including endometritis, retained foetuses and rupture of uterus (Kirk et al., 2005). Kirk et al. (2005) also found that body condition differed between the groups of euthanized sows and sows dying unassisted, with euthanized sows having a lower body condition than sows dying unassisted.

Thorup et al. (2010) investigated causes of death in lactating sows based on necropsies. They found that most sows died of prolapse (22 %), including both rectal prolapse and uterine prolapse. Sasaki and Koketsu (2008) also demonstrated this as a frequent cause of death for sows dying unassisted (10.8 %) in Japan. The other causes of death reported by Thorup et al. (2010): stomach ulcer, farrowing problems and torsion of organs, have also been indicated as main causes of death in other studies, for instance in Sasaki and Koketsu (2008) where peripartum problems accounted for 18.3 % of all sows dying unassisted. Thorup et al. (2010) did not demonstrate leg problems as a primary cause of euthanasia in contrast to other studies (e.g. Kirk et al., 2005; Vestergaard et al., 2004). Likewise, leg problems were not found as a cause of death in a retrospective study of mortality of sows in Québec, where causes of death were determined from necropsies (Chagnon et al., 1991). Chagnon et al. (1991) found that heart failure and torsion of abdominal organs caused most deaths, 31.4 % and 15.3 %, respectively, (see Table 3), which is in agreement with Danish findings by e.g. Vestergaard et al. (2004) and Thorup et al. (2010). More than 60 % of the heart failures occurred in the period around farrowing (Chagnon et al., 1991).

In the study by Engblom et al. (2007) on causes of sow removal in Sweden, 26.6 % of the sows being euthanized out of the total number being removed (death + slaughter) were categorized as having an inferior body condition including conditions like sores on the shoulders, general bad condition and abscesses. In a



subsequent study performing necropsies (Engblom et al., 2008), the main cause of death was arthritis (36.4 % of all dead sows examined).

Table 2. Overview from literature reporting causes of sow mortality assessed by the farmer for sows dying unassisted (shown as distribution of causes in %).

	Unassisted deaths (%)			
	Information from farmer			
	Christensen et al. (1995)	Pedersen and Brendstrup (1998)	Vestergaard et al. (2004)	Sasaki and Kokeitsu (2008)
Stomach and intestine problems	21.2	22.2	-	-
Urinary system	15.2	-	-	-
Leg problems	16.1	6.3	3	4.2
Farrowing complications	10.7	16.6	13	18.3
Disease	-	-	21.6	15.1
Prolapse	-	-	-	10.8
Udder infection/metritis	-	6.3	-	-
Blood in urine, bloody discharge	-	5.6	-	-
Injury	-	6.3	3.6	-
Body condition	-	-	4.5	-
Reproduction	-	-	0.9	-
Breeding	-	-	0.4	-
Behaviour	-	-	0.8	-
Other/not registered	15/21.8	36.7	52.2	51.6

Table 3. Overview from literature reporting causes of sow mortality assessed by necropsies for sows dying unassisted. (shown as distribution of causes in %).

	Unassisted deaths (%) Necropsies			
	Chagnon et al. (1991) <sup>d</sup>	Vestergaard et al. (2004)	Kirk et al. (2005)	Thorup et al. (2010) <sup>d</sup>
Stomach and intestine problems	3.6	18	45 <sup>c</sup>	21
Heart problems	31.4	11	-	11
Torsion of organs	15.3	24	-	9
Farrowing complications	-	23	24	11
Disease	3.6 <sup>e</sup>	-	13 <sup>b</sup>	-
Urinary system	14.6	-	5	-
Udder infection/metritis	6.6	-	-	-
Laceration	-	-	-	7
Leg problems	-	-	0 <sup>a</sup>	-
No specific cause	8 <sup>f</sup>	15	-	5
Other/not registered	16.8	9	13	36

<sup>a</sup>locomotive system, <sup>b</sup>miscellaneous, <sup>c</sup>gastrointestinal system and spleen, <sup>d</sup>results are not separated into sows dying unassisted and euthanized sows, <sup>e</sup>pneumonia, <sup>f</sup>downer sow syndrome.

Table 4. Overview from literature reporting causes of sow mortality assessed by the farmer for euthanized sows (shown as distribution of causes in %).

	Euthanized (%) Information from farmer			
	Christensen et al. (1995)	Pedersen and Bendstrup (1998)	Vestergaard et al. (2004)	Engblom et al. (2007) <sup>a</sup>
Leg problems	28.5	76.2	56	24.8
Farrowing complications	20.9	9.2	5.3	-
Stomach and intestine problems	17.1	1.5	-	-
Injury	10.7	3.4	9.7	52.0 <sup>b</sup>
Urinary system	13.1	-	-	-
Disease	-	-	10.7	-
Body condition	-	-	3.1	7.4
Reproduction	-	-	3.3	5.3
Udder infection/metritis	-	-	-	4.2
Breeding	-	-	0.2	-
Other/not registered	9.5	9.7	11.7	6.2

<sup>a</sup>euthanized out of total number of sows removed, <sup>b</sup>traumatic injuries incl. acute injuries, wounds, leg fracture, paralysis.

Table 5. Overview from literature reporting causes of sow mortality assessed by necropsies for euthanized sows (shown as distribution of causes in %).

	Euthanized (%) Necropsies		
	Vestergaard et al. (2004)	Kirk et al. (2005)	Thorup et al. (2010) <sup>d</sup>
Leg problems	70	72 <sup>a</sup>	6
Prolaps	-	-	22
Circulation disturbance	-	-	33
Infection	12	-	-
Farrowing complications	10	9	6
Disease	-	6 <sup>b</sup>	-
Stomach and intestine problems	-	4 <sup>c</sup>	33 <sup>e</sup>
Urinary system	-	1	-
Liver damage	-	-	-
No specific cause	8	-	-
Other/not registered	-	6	-

<sup>a</sup>locomotive system, <sup>b</sup>miscellaneous, <sup>c</sup>gastrointestinal system and spleen, <sup>d</sup>results are not separated into sows dying unassisted and euthanized sows, <sup>e</sup>bleeding intestine.

### 3.2 Results from a pilot study on sow mortality on Danish herds

In 2015 a pilot study on sow mortality were conducted on a sample of Danish pig herds. While visiting the herds to conduct clinical examinations on sows for another project, we asked questions concerning information of the cause of death of the last sow, which died in the herd. The herds were contacted again by telephone after 2-3 months and asked the same questions. A total of 40 herds participated in the study, with 33 of these providing information on two occasions of sow mortality. This provided detailed information on sow mortality considering 76 sows.

The data on dead sows were divided into sows being euthanized or sows dying unassisted, with a distribution of 51% and 49 %, respectively. In the following the results are presented for these categories of death.

The distribution of euthanized sows and sows dying unassisted according to parity is shown in Figure 3. It appears that most sows were euthanized in parity 2 and 5, whereas most sows died unassisted in parity 1, 2 and 4.

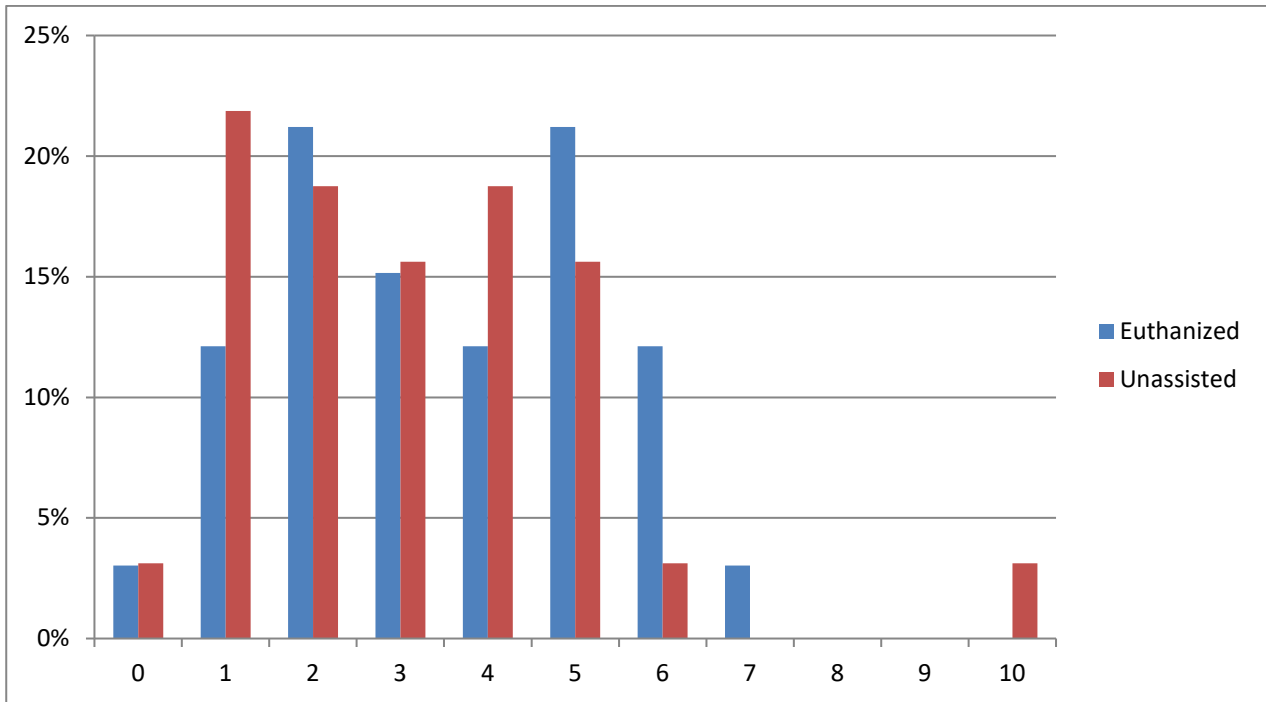


Figure 3. Distribution of dead sows according to parity (0-10) stratified by euthanasia and unassisted dead.

The production system can have an influence on management of diseased sows, as the production system resembles the production cycle of the sows. The results from the pilot study in Danish herds showed that more sows died unassisted in the farrowing and service unit, whereas more sows were euthanized in the sick pens, independent of which section they came from. In the pregnancy unit, an equal distribution of euthanasia and unassisted deaths was observed (see Figure 4).

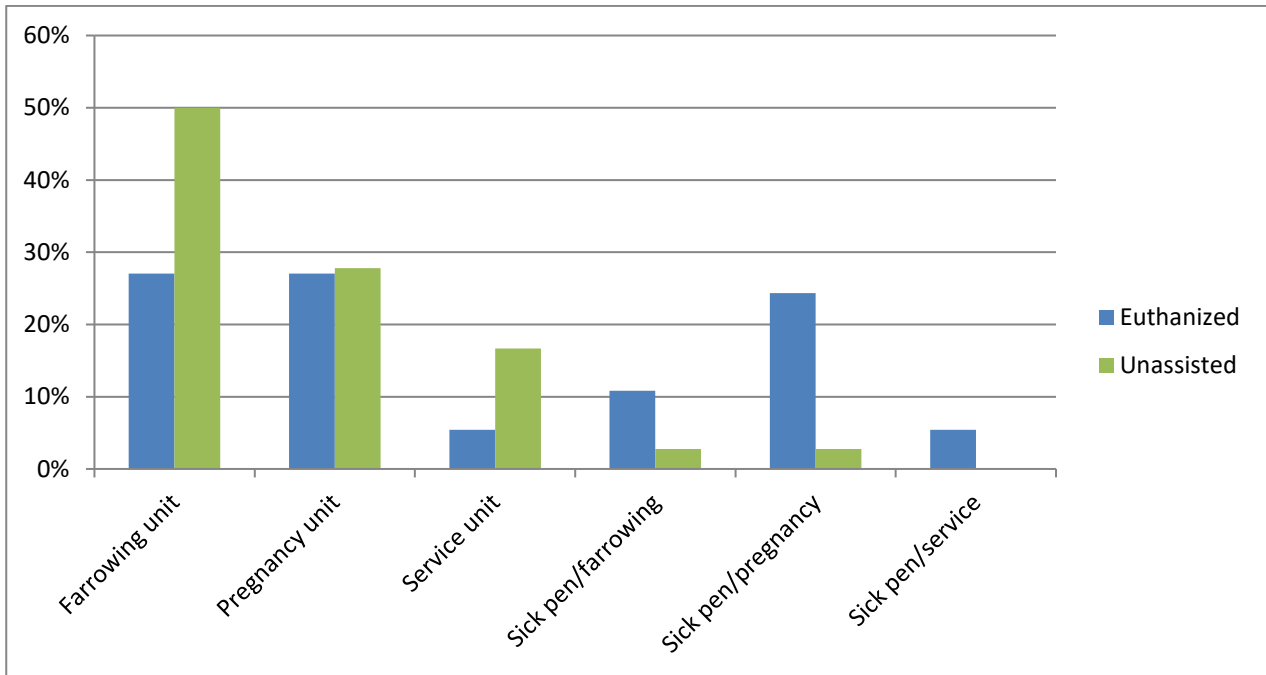


Figure 4. Distribution of dead sows according to production system stratified by euthanasia and unassisted death.

Table 6 presents the causes of death defined by the farmers in the pilot study. Most sows died due to leg problems, with almost half of the sows with a registered cause of death placed in the category of 'other cause', or where the farmer was not able to determine a cause of death (don't know). In the category 'other cause' farmers mentioned toxication, not thriving, uterine prolapse, lesions, encephalitis, malignant edema, abortion etc. as causes of death.

When the percentage of dead sows were stratified in euthanized sows and sows dying unassisted, the results showed that most sows were euthanized due to leg problems, whereas sows dying unassisted were most often due to other causes or the farmer did not know the cause.

Table 6. Causes of death for euthanized sows and sows dying unassisted in the pilot study.

Cause of death	No. of sows	%
Leg problems	29	38%
Don't know	20	26%
Other cause	15	20%
Stomach ulcer	6	8%
Complication farrowing	4	5%
Rectal prolapse	1	1%
Body condition	1	1%
Shoulder lesion	0	0%

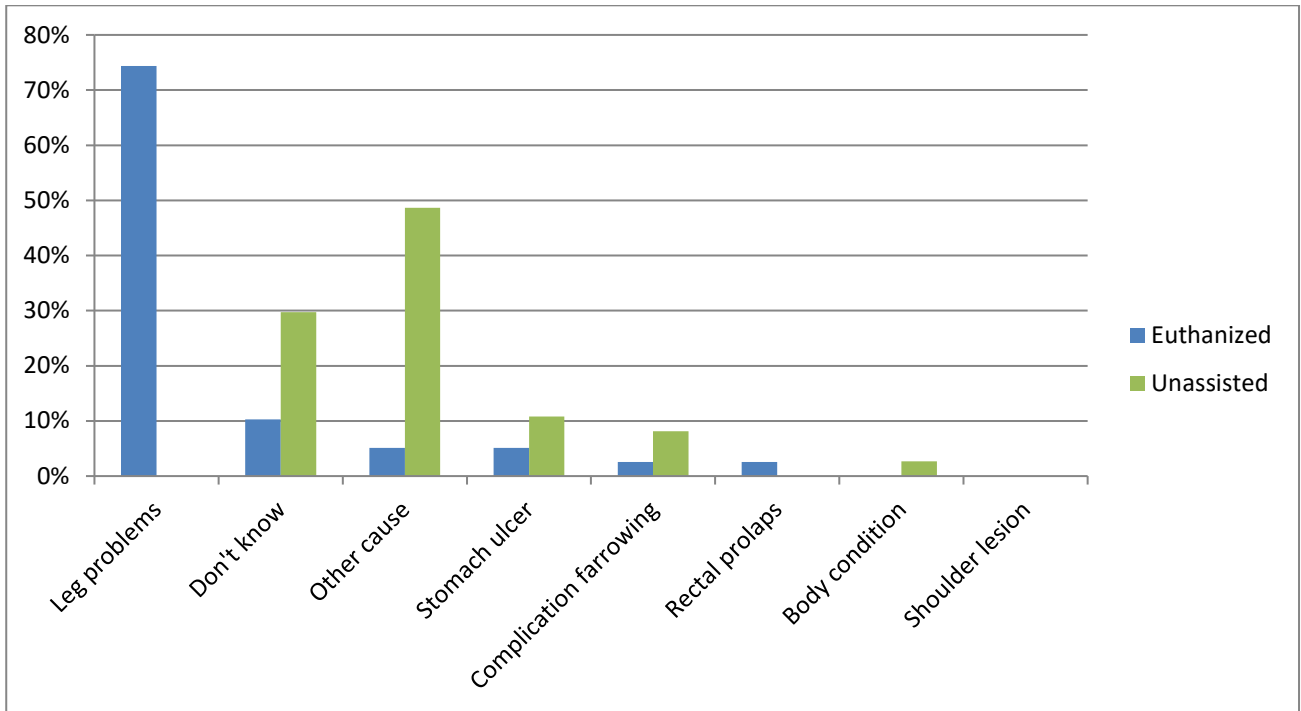


Figure 5. Percentage of euthanized sows and sows dying unassisted based on cause of death.



When causes of death were stratified according to production section, the results showed that leg problems were the most frequent cause of death in the sick pens housing animals from the pregnancy and service unit. Deaths due to leg problems were also a frequent cause in the farrowing unit and pregnancy unit. Stomach ulcers and rectal prolapse were most frequent in sick pens where the animals came from the farrowing unit. As expected, complications around farrowing were a cause of death only in the farrowing section, but was not as frequent as leg problems. The distribution of causes of death for the different production sections can be seen in Figure 6.

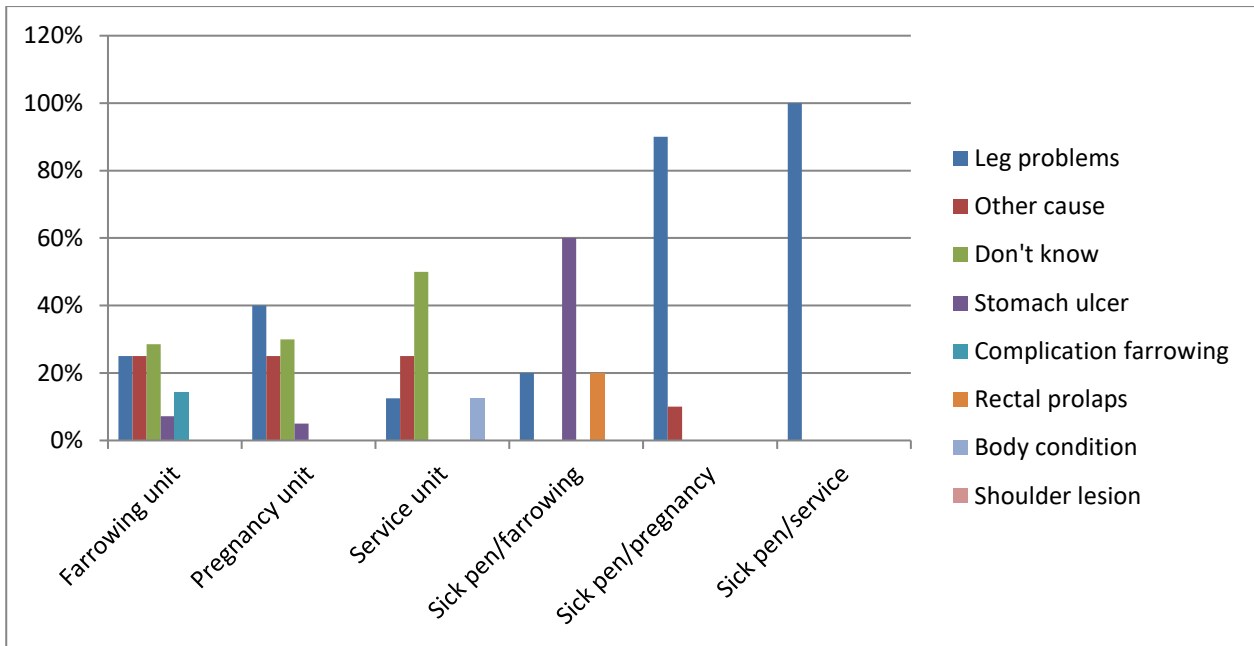


Figure 6. Cause of death based on production section.

## 4. Risk factors for sow mortality

### 4.1 Factors related to stage of production cycle and parity

In the study by Pedersen and Brendstrup (1998) investigating sow mortality in Danish herds, the time of death for euthanized sows and sows dying unassisted was registered according to stage of production cycle for the individual sow. The levels of mortality in different periods across the production cycle are shown in Figure 7. The results showed that a relatively large proportion (12 %) died during the first days after weaning. Also, a relatively large proportion of sows (16 %) died in the period before and around farrowing. Combining the causes of death, with the time of death, showed that death due to leg problems, which was the most frequent reason for killing, increased during pregnancy with a maximum in early lactation (Pedersen & Brendstrup 1998). It was suggested that this was caused by pregnancy being a strain on the legs of the sows, but euthanasia postponed to after farrowing. Also, euthanasia increased after weaning due to management decisions not wanting to inseminate and reproduce a sow having a predisposition to leg problems. Causes of death in the period around farrowing with a high mortality were suggested to be caused by problems with metabolism, which is hardly strained in this period.

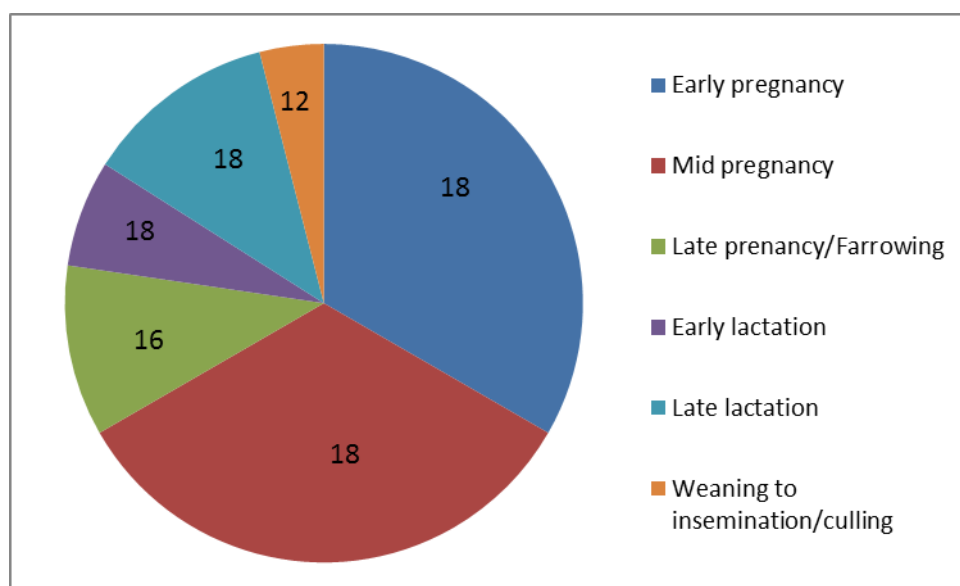


Figure 7. Distribution of dead sows (%) between different stages of the production cycle. Size of each period represents the period length (After Pedersen and Brendstrup 1998).

In the study by Vestergaard et al. (2004) necropsies were performed for a part of the dead sows registered in the study period. This additional information on the sows showed that the time around farrowing was associated with a higher risk of death. Thorup et al. (2010) also demonstrated that time around farrowing was a period with a high risk of dying. Among sows dying during farrowing and during lactation, they found that more than 30 % of the sows died during or just after farrowing, with a small percentage in the days after



farrowing (day 6-10), and increasing levels again after day 10 post-partum and until weaning. An observational study of sow mortality based on necropsies from breeding herds in Québec showed that 42.1 % of 133 sows/gilts, either euthanized or dead unassisted, died in the period around farrowing (3 days  $\pm$  farrowing), 16.5 % during lactation, 6 % postweaning and 35.4 % during gestation (Chagnon et al., 1991). Also, in the study by Engblom et al. (2007) the proportion of sows found dead was higher in the first few days after farrowing compared to the rest of the production period, in agreement with Sasaki and Koketsu (2008) according to whom 40 % of all sows dying unassisted died in the peripartum period just before or within a week after farrowing.

In a study by Kirk et al. (2005), performing necropsies of 265 sows from 10 Danish pig herds, half the sows, both euthanized and sows dying unassisted, died in the lactation period, with 48 % being euthanized from 1 to 5 weeks after farrowing and 50 % dying unassisted from 1-4 weeks after farrowing.

Parity or age of the sows was also found to be an influencing factor on sow mortality. Kirk et al. (2005) found that approximately 40 % of the sows in their study were dead before the second parity, with no statistical difference in parity distribution between sows euthanized or sows dying unassisted. Engblom et al. (2007) found that it was among low parity sows (parity 1-3) that the highest proportion of sows died unassisted. The proportion of euthanized sows increased with parity, so older sows were more often euthanized (or removed due to slaughter) than found unassisted dead. In contrast to these findings, a retrospective observational study on sow mortality in USA indicated that older sows had a higher annual risk of death (sows dying unassisted or euthanized) compared to gilts and young sows, with an annual mortality risk ranging from 4.03 % for gilts to 7.88 % for parities higher than seven (Koketsu 2000). A similar study performed in Québec reported an average parity of dead sows of 4.2 with 59 % of the sows being in parity 4 or lower, based on necropsies of death sows and gilts (Chagnon et al., 1991). Sasaki and Koketsu (2008) did also report a high mortality in high parity sows; however, with sows in their first parity also having a high risk of dying shown by a higher mortality risk in parity 1 than in parity 2.

## **4.2 Season as a risk factor for sow mortality**

Season seems to play a role on risk of death because sow mortality varies throughout the year. Numbers from DAKA (Frandsen 2015) shows an increase in the number of dead sows in the summer period compared to the winter period (Figure 8). This is consistent almost every year from 2008 to 2014. A seasonal effect on sow mortality has also been reported in different scientific studies.

Iida and Koketsu (2014) investigated the association between climatic factors and the occurrence of death of sows around farrowing in Japanese pig herds. They found a higher risk of dying during the hot and humid season for low parity sows (gilts and parity 1 sows) exposed to high temperatures compared to higher parity sows (parity 2 sows or higher). The opposite was found during the cold season where high parity sows (parity 4 sows or higher) exposed to low temperatures had a higher risk of dying compared to low parity sows and

gilts. A higher incidence of sow mortality during summer was also found in the study by Koketsu (2000), studying sow mortality on swine breeding herds in USA. This was also the results by Chagnon et al. (1991), investigating sow mortality in breeding herds in Québec, with a higher mortality in July, August and October and one third of the sows dying in July and August.

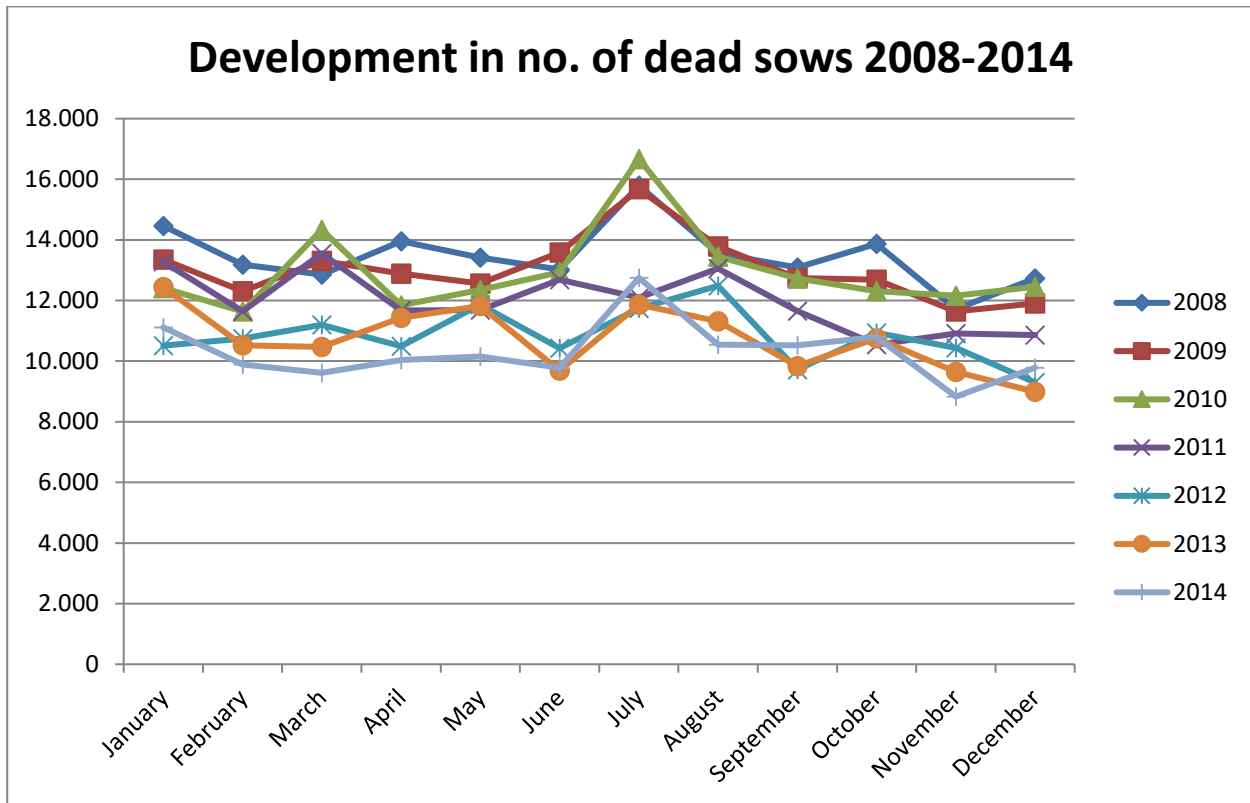


Figure 8. Monthly development in no of dead sows from 2008 to 2014.

### 4.3 Factors related to management and housing

Management includes the daily handling of animals including the strategies for production set in the individual herds. The housing system is the physical surroundings in which the animals are kept. Both of these factors will affect the mortality in a specific herd, both in regard to mortality rate and causes of death.

In the study by Pedersen and Brendstrup (1998) on causes of mortality of 9000 sows, the productivity of the sows measured as number of weaned piglets per year sow was associated with sow mortality, showing that high productivity was associated with a low mortality. Pedersen and Brendstrup (1998) concluded that the strain of a high productivity did not cause increased risk of mortality among the sows, possibly due to a good management and an early treatment in case of signs of discomfort and disease for sows with a high productivity. There was no association between the number of euthanized sows and productivity level, saying that herds with a high productivity did not euthanize more or less sows than herds with a lower productivity. However, different thresholds and strategies for euthanasia between herds would affect the mortality rate and can explain between herd variations (Jensen et al., 2012). Pedersen and Brendstrup (1998) suggested that in

order to reduce sow mortality, focus should be on management of the individual herds including supervision of animals and medical treatment. Factors causing increased mortality risk may also be related to the housing system, with Jensen et al. (2012) finding solid floors in the gestation unit to increase mortality risk compared to sows kept on non-solid floors. This was suggested to be caused by a higher probability of solid floors being covered in faeces and urine resulting in poorer hygiene and more slipperiness causing a higher risk of infections and leg problems due to falling.

Jensen et al (2012) did not find a relation between herd size and mortality rate, which is in agreement with the findings by Lida and Koketsu (2014). Sasaki and Koketsu (2008) found an increased mortality risk in smaller herds.

Type of feed was found to be associated with sow mortality in the study by Pedersen and Brendstrup (1998), where herds feeding dry feed in the section with pregnant and lactating sows had a higher mortality than herds feeding wet feed (7.3 % vs. 5 %). They suggest this to be caused by the high content of liquid in wet feed causing a severe rinsing of the urinary system. However, the data material was unevenly distributed with only 5 herds out of the 29 herds included in the study using wet feed. This may have affected the results.

In a retrospective case-control study (high mortality rate sow herds versus low mortality rate sow herds) conducted in France, Abiven et al., (1998) identified feeding frequency of pregnant sows as a risk factor. Providing three meals per day instead of two was associated with low mortality rate.

#### **4.4 Factors related to health status of the sow**

Investigation of risk factors for sow mortality by Jensen et al. (2012) demonstrated that for pregnant sows, the evidence of vulva bites and unwillingness to stand were associated with an increased mortality risk. Unwillingness to stand could be associated with leg problems, which in other studies were found to be a main cause for euthanasia of sows (Christensen et al., 1995; Pedersen and Brendstrup 1998; Kirk et al., 2005; Engblom et al., 2007). However, unwillingness to stand could also indicate other health disorders causing a preference for lying down. As regards vulva bites, which is caused by aggressiveness among loose-housed sows often in relation to feeding, e.g. in systems with electronic sow feeders (Scott et al., 2009), this was suggested to increase mortality as it is often weak, low-ranging sows that get vulva bites and as vulva bites may cause dystocia (difficulties in giving birth). The colour of the vulva indicated the degree of anaemia of the sows, and although only found in a few sows, these anaemic sows had the highest risk of mortality (Scott et al., 2009). It was not possible to fully investigate the cause of a pale vulva colour, but it was suggested that it might be caused by stress-related diseases increasing mortality. For lactating sows, factors such as low body condition, presence of shoulder ulcers and pale vulva colour were associated with an increased risk of mortality (Jensen et al. 2012). A low body condition was suggested by Jensen et al. (2012) to increase mortality due to an increased risk of shoulder ulcers, which was also found to increase the mortality risk in this study due to

increased rate of euthanasia of sows with shoulder ulcers. Moreover, a low body condition could also indicate other health problems increasing the mortality risk.

In a retrospective case-control study (high mortality rate sow herds versus low mortality rate sow herds) conducted in France, Abiven et al., (1998) identified urinary tract infections, metritis and lameness as being significantly associated with high mortality.

## 5. Conclusion

Sow mortality in Denmark has decreased during the last seven years. However, sow mortality is still high when compared to other countries and needs to be further reduced. The dead sows fall into two equally sized groups, unassisted dead sows and euthanized sows. The dominant reason for euthanasia of a sow is leg problems. The reason for unassisted death is often not known. Euthanized sows are typically found in the loose housing unit for pregnant sows, in the farrowing unit or in a sick pen. A major part of the unassisted dead sows was found in the farrowing unit. When examined by means of a necropsy the cause of unassisted death is mainly due to heart problems, torsion of organs and farrowing complications. Identified risk factors for sow mortality include: hot summers, solid floor in the gestation unit combined with poor hygiene. Large variation between herds indicates the importance of management in preventing sow mortality.

## 6. Suggestions for strategies to reduce sow mortality

Sow mortality reductions may be facilitated through an advisory effort and/or through initiatives facilitated by authorities. Below we have listed initiatives summarised in the advisory project SoLiv, and we have listed recommendations based on our study focusing on initiatives, which can be facilitated by authorities.

### 6.1 Strategies for reducing sow mortality used in the project SoLiv

In the advisory project SoLiv tasks were conducted to reduce sow mortality in 17 problem herds. During a three-year period (2007-10), these 17 herds reduced their sow mortality by an average of 5 %-points (Vestergaard et al., 2016). The initiatives, which were based on a common advisory effort made by production consultants and veterinary practitioners on each herd for reducing sow mortality, include:

- Optimizing housing and feeding systems
- Improved feeding hygiene by weekly control
- Improved training facilities for introducing gilts to loose housing units
- Systematic selection of gilts
- Strategies for introduction of sows to loose housing reducing numbers of movement and mixing
- Body condition control by feeding
- Systematic planning of daily surveillance
- Systematic use of sick pens with dairy recording
- 3-5 daily feedings in lactation unit
- Quarterly stomach examinations on culled sows for improved management
- Systematic recording of culling reasons

### 6.2 Recommendations

Sow mortality has two equally large sources: sows dying unassisted and euthanized sows with different causalities. Recommendations should therefore target these two groups separately. Our study leads to the following non-prioritized recommendations:

Euthanized sows:

- A major part of euthanized sows is due to lameness, therefore systematic surveillance including seeing all sows walk every day, using an easy recording of lame sows and using observation lists from ESF should be done
- Systematic action on lame sows : Use of sick pens and planned use of antibiotics/analgesics
- Improved self-inspection procedures made by the producer and followed up by veterinary welfare visits including sow mortality as a key focus area should be implemented on all sow herds.
- Focus on sick pens – quality and capacity

- Systematic strategies including clear criteria for euthanasia should be implemented in all sow herds
- There is a need for more research in the prevention of lameness in sow herds and development of pen design for pregnant and insemination units

Unassisted death of sows:

- Information on time of death and body condition of a dead sow should be collected in all sow herds
- Systematic strategies for using necropsies should be an integrated part of herd health advisory agreements
- Information on stomach ulcers from culled sows should be provided systematically by the abattoirs
- Systematic plans for diagnoses leading to action on all main diseases should be available in all sow herds
- More research in causes and methods for preventing unassisted death focusing on farrowing and lactation is needed.

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Department of Food Science  
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