

Faculty of Veterinary Science

Szent István University

Department of Animal Hygiene, Herd-Health and Veterinary  
Ethology

# **Predisposing factors for piglet mortality and effects on photoperiod influence.**

(Field study and hypothesis assessment)

Malene Hermansen

Supervisor: Dr. Adorján András

Szent István University Department of Animal Hygiene, Herd-  
Health and Veterinary Ethology

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# 1 Preface

As a veterinary student I had eager to learn and to take part in practical work. The winter of 2013 I was lucky to be participating on the Rustan farm during a farrowing period. What caught my attention was the high number of dead piglets found in the morning, assumed to be crushed during the night. On one particular morning there where no dead piglets and I was curious and wanted to know why. The only difference I could figure out was that we forgot to turn the roof light off the night before. I asked the farmer and the local veterinarian and I searched for articles online to see if illumination during the night could have had any influence on why there where no dead piglets that particular morning, or if it just was an coincidence. As I started this process I didn't find any specific articles regarding this topic and that's when I decided to test this hypothesis myself. Could providing artificial lightning during the night decrease the amount of crushed piglets by helping the sow orientate herself?

## 2 Definitions

**Sow:** a female pig after the first farrowing.

**Farrowing sow:** a female pig between the perinatal period and the weaning of the piglets

**Piglet born:** Registration of piglets born, alive or dead.

**Neonatal death/ pre-weaning mortality:** Piglets born alive, but which die before weaning 5 weeks postpartum.

**Crushed piglet:** Piglet entrapment beneath the sow, often with death as result.

**Big litter:** Litter with over 14 piglets.

**Hypoxia:** Inadequate oxygen supply to cells and tissues of the body, with altered or interrupted cellular energy metabolism.

**Cross fostering:** Mixing of piglets between litters to even out differences among the piglets.

**Cross nursing:** Keeping a sow from the previous farrowing cycle to nurse piglets from litters which are too big.

**Rolling-** Sow rolls from sternal to lateral recumbancy or reverse without any other posture involved.

**Lateral recumbence:** Sow is lying on the side with one shoulder or hind quarter/ham touching the floor. Three or four legs can be seen on one side of the sow.

**Sternal recumbence-** Sow is lying on the belly without a shoulder touching the floor.

**Trapping/crushing, rolling** - Sow traps or crush a piglet in rolling movement <sup>1</sup>

**Trapping/crushing, lying down** - Sow traps or crush a piglet in lying down movement<sup>2</sup>

**Loose farrowing system:** Pen designed for farrowing, where the sow is not crated or tied, but can freely move and lie down.

**Farrowing crates:** Farrowing systems where the sows are individually imprisoned in a metal cage. Usually from the week before farrowing until weaning, with the aim to reduce crushing.

**Mastitis:** A bacterial infection of the udder. In many cases only one or two glands are affected.

**Metritis:** An infection of the uterus, presented as vulvar discharges

**Agalactia:** A reduction, or total loss, of milk production by the sow. Often not detected until the nursing litter show signs of hunger and/or weight loss.

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<sup>1</sup>, <sup>2</sup> Trapping or crushing of piglets included the following incidents: the piglet is trapped under the sow, but escaped because of reaction of the sow; the piglet is trapped under the sow, but escaped by itself; the piglet is crushed under the sow and dies.

### 3 Introduction

The increasing intensity on swine production makes the pre-weaning piglet mortality a key factor and a major economical issue in today`s herds. In Europe`s and North America`s major swine producing countries the neonatal mortality rates contributes to an average of 11-19% (Kirkden, Broom, & Andersen, 2013). As well as there is an increasing pressure on the production rates and economy, there are also increasing demands on animal welfare. This leads the porcine industry to face new challenges because it will be necessary to construct and develop new farming systems and management procedures. These procedure needs to be practically both workable and economically profitable. The design of reliable farrowing and nursing pens for loose house systems are an example of this. Such new systems must be competeable with the creates regarding piglets mortality and especially the piglet deaths due to crushing has to be reduced (Danholt, Moustsen, Nielsen, & Kristensen, 2011). These aspects put together represent a rising challenge to the practical aspect of todays swine management (Wischner, 2009).

In Norway there has been great changes in the agriculture during the last few decades. It now prohibited to use sow fixation and farrowing creates to the benefit of loose farrowing pens. The development of the breeding programs has resulted in increased litters sizes, and as the key factor for the breeding companies is to achieve the highest possible weaning rates of fast growing and good weight piglets, we are often experiencing an exceeded rearing capacity of the sow (Alonzo-Spilsbury, Ramirez-Neoechea.R, & M, 2007). This will be of major significance in the postpartum period and highly influence the piglet mortality (Rootwelt, 2010).

In Norwegian swine facilities the neonatal piglet mortality rate has an average of 14-15%. Most crucial are the first 48 hours after parturition (Andersen, Berg, Haukvik, & Bøe, 2005). The variations are related to different environmental and management conditions, such as genotype, housing, nutrition and management (Kirkden et al., 2013). The most important causes of these deaths are crushing and starvation. There is a strong connection between these two due to the fact that starvation as a primary factor is influencing crushing to a higher extent (Weary 1996). Altogether starvation and crushing may constitute to 50-80 % of the deaths from birth to weaning (Svendsen 1989). Other causes of death constitutes to congenital abnormalities (5%), diseases (6%), trauma, whole litter loss and other unidentified causes. In

additions to the loss of live-born piglets, 4-8% all piglets die prior to or at the time of parturition (Dyck & Swierstra, 1987). Husbandry skills, way of keeping (loose pens or farrowing crates), maternal instincts and sows health are important factors playing a central role in these estimations (Alonzo-Spilsbury et al., 2007).

**Table 1: Distribution of mortality from parturition until weaning**

Cause of death	Day								Week				Total	Birth wt (kg)†	% of no. born	
	0	1	2	3	4	5	6	7	2	3	4	5				
Stillbirth (AP)‡	34													34		1.4
(IP)	93													93	1.07±0.04ab	3.9
Crushed		43	48	21	11	1	2	3		6	1			136	1.10±0.03ab	5.7
		§(+0.02)	(-0.01)	(+0.03)	(-0.09)	(0.00)	(+0.65)	(+0.50)		(+0.61)	(+0.40)					
Starvation			10	20	28	27	21	15		24	7	1		153	1.03±0.03b	6.4
			(-0.08)	(-0.08)	(-0.22)	(-0.24)	(-0.22)	(-0.33)		(-0.27)	(0.00)	(+0.30)				
Euthanized		2	13	10	19	2	1	3		2	12		1	65	1.22±0.05a	2.7
		(0.00)	(+0.01)	(+0.05)	(-0.02)	(-0.25)	(-0.30)	(-0.40)		(+0.35)	(+1.84)		(+1.50)			
Exposure			4	4	1					3	1			13	0.85±0.05c	0.6
			(-0.03)	(-0.15)	(-0.20)					(-0.13)	(+0.40)					
Abnormal		1		2	2									5	1.24±0.09a	0.2
		(0.00)		(-0.05)	(-0.10)											
Diseased			1	1	2		1							5	0.92±0.04c	0.2
			(-0.10)	(-0.10)	(-0.15)		(-0.20)									
Unidentified		17	10	1	1	4	4	1		16	5	4	2	65	1.16±0.05a	2.7
		(0.00)	(-0.01)	(+0.30)	(+0.30)	(-0.20)	(+0.08)	(+1.30)		(+0.40)	(+1.88)	(+1.73)	(+7.20)			
Total	127	63	86	59	64	34	29	22		51	26	5	3	569		23.8
Birth wt (kg)†		1.04±	1.05±	0.94±	1.03±	1.13±	1.10±	1.31±		1.15±	1.42±	1.10±	1.20±			
		0.04ab	0.03ab	0.03ab	0.03ab	0.05ac	0.09abc	0.06d		0.02c	0.06d	0.15abcd	0.17abcd			
% of deaths	22.3	11.1	15.1	10.4	11.2	6.0	5.1	3.9		9.0	4.5	0.9	0.5			

†Values are means ± standard error of the mean. Mean birth weight of all piglets born alive was 1.31±0.01 kg.

‡AP, antipartum (death late in gestation); IP, intrapartum (death during parturition).

§Numbers in parentheses are the mean weight change from birth to death for each group of piglets.

a-d Values with different letters are significantly different ( $P < 0.05$ ).

*Distribution of mortality from parturition until weaning. Arranged by cause of death, weight change from birth to death and birth weight for each cause of death and day of death (Dyck & Swierstra, 1987).*

Pre-weaning mortality shows great variations among the different countries and herds due to the different management procedures performed under and after the critical farrowing period (Kirkden et al., 2013). The modernisation of swine production requires new thinking and acknowledgments to optimise both the results and the work for the producers. Since the highest mortality rate occurs at time around farrowing, the periparturient periods are particularly important regarding management interventions (Kirkden et al., 2013). On the practical aspects several measurements are performed to decrease neonatal mortality, depending on the farmers effort and production scale. The most effective interventions include drying the piglets and placing them under an artificially heated area (e.g. piglet corner), breathing assistance, supplementary feeding of colostrum and cross-fostering (Kirkden et al., 2013). These management procedures might increase the piglet survival with

up to 95% of the live born piglets (Dyck & Swierstra, 1987). The sows conditions and health are also of particular importance and interventions such as assisting dystocic sows, good hygiene measurements, preventions and treatment of hypogalactia of the sow can be crucial regarding piglet survival the first week (Kirkden et al., 2013).

The aim of this thesis is to study the contributing factors leading to pre-weaning piglet mortality and testing my hypothesis whether artificial illumination during dark periods might improve the sows orientation and thereby crush less piglets during the periparturient period. I performed this research by keeping the roof light on the first week after farrowing during the dark winter months in Norway.

In in the literature review I will focus on piglet mortality from birth to weaning, especially during the first week of life. I will go trough both contributing maternal factors such as the sow's behaviour and piglets factors like starvation and hypothermia. My main focus will relate to the predisposing factors of crushing and management on ways to prevent pre-weaning mortality.

This thesis will be based on a literature review, a questionnaire and a practical fieldwork. The literature review and theoretical part was written during the summer and autumn of 2015. The research started the winter of 2013 when I was introduced to the issue of high piglet mortality and crushing during private practical work. I started the fieldwork the year after and continued over two periods in November 2013 to February 2014 and November 2014 to February 2015. In these months there will be complete darkness if no artificial light is provided. The practical part was performed on one selected farm, Rustan Farm, located in Re, Vestfold. The farmer where very helpful with the project and gave me access to all necessary data files, answered all my questions presented in the interviews and helped with other practical issues that came along on the way.

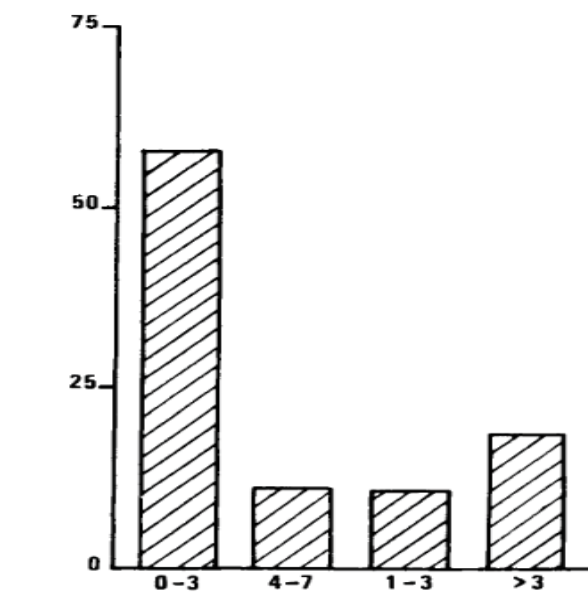
## 4 Literature review

### 4.1 Pre-weaning mortality of piglets

There are great variations in the vigour of piglets born in the same litter, which often differentiates considerably at the time of parturition. This relation occurs due to the variation of host factors such as genetic background, birth weight and oxygen flow under and at parturition (Alonzo-Spilsbury et al., 2007).

The first hours after birth are the most important regarding prevention of piglet mortality. These hours are critical considering thermoregulation and feed intake needed to gain viability. Small piglets and those born at the end of the parturition are particularly susceptible (White, Anderson, & Bate, 1996). The most common causes of pre-weaning deaths are oxygen deficiency (before or under birth), starvation and crushing, which mostly occurs during the first few days after parturition. Starvation and crushing is often written about in the generic term together with hypothermia, as it could be difficult to differentiate between these when the piglets are found dead. What we do know is that these factors has definite a correlation (Rootwelt, 2010). Crushing represent the most important factor when kept in loose farrowing pens (Arey & Sancha, 1996), which and contributes to over 50 % of the mortality rate (Inger Lise Andersen, 2005).

**Fig. 1. Pre-weaning mortality**



*Illustrates death rate of piglets distributed in weeks.*

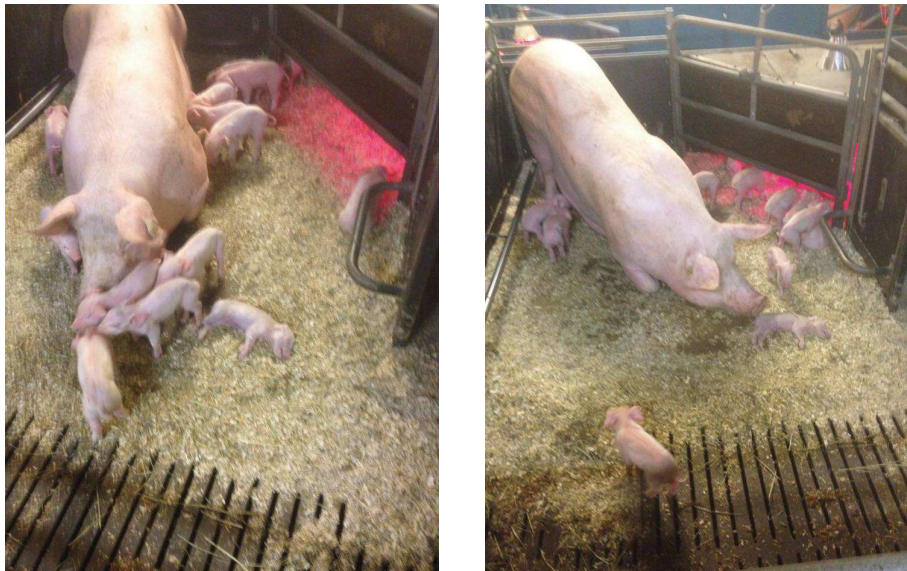
*Adapted from J. Le Dividich and Noblet (1983).*



## 4.2 Crushing

Piglet crushing is the result of a sow's postural changes leading to entrapment of the piglet either underneath her body or crushed against the wall (Alonzo-Spilsbury et al., 2007). Crushing itself can be a primary cause of death, but it is mostly related to other factors as primary causes. Starvation, hypothermia, asphyxia, small and weak piglets and sows health are examples common contributing factors of crushing. (Rosvold, Schjerpen, Haukvik, & Andersen, 2007). Hunger and hypothermia forces the piglets seek the sow's udder outside of the normal routine periods of feeding and nursing. This behaviour typically occurs when the litters are too big and uneven. These piglets are therefore more prone to be crushed than those who succeed to suckle (Rosvold et al., 2007).

**Picture 1. Lying down of the sow.**



*Illustration of a sow trying to lay down with careful movements. One dead piglet in the centre of the pen assumed to be crushed earlier, typically small and thin (Picture taken by me, Rustan farm January 2015).*

Crushing related to the postural changes of sow is mostly due to her lying down and rolling behaviour. In a study done by Danholt, Moustsen, Nielsen, & Kristensen in 2011 shows that 63% of the incidents related to crushing is an consequence of piglets being trapped by the sow, typically when the sow expresses rolling behaviour. The last 37% incidents are related to the consequence of sitting sown or lying down either to sternal or lateral recumbency (Danholt et al., 2011). When piglets are trapped beneath the sow they would normally scream

and make a distress call, if they are able to. A sow with good maternal instincts will quickly respond and rise and the piglet may survive (Kirkden et al. 2013).

As piglet crushing leads to severe production losses and decreased economical outcome, several factors has been tried out to decrease this mortality rate. Farrowing crates are commonly used in several countries, but to not satisfy the welfare demands. Loose farrowing management systems stimulate maternal behaviour in a more positive manner. Recommended strategies to reduce crushing mortality is to evaluate all the contributing factors and adjust the management's procedures according to this (Kirkden et al. 2013).

### **4.3 The most common causes leading to crushing and piglet mortality**

#### **4.3.1 Starvation**

Starvation and dehydration occurs due to either failure of the sow to produce enough milk because of variable reasons or due to the failure of the piglets to achieve enough nutrients (Kirkden et al., 2013). Achieving an appropriate amount of colostrum right after birth is of vital importance to the piglets. If the piglets succeed to find the teats and obtain an adequate amount of colostrum within 45 min, their chance of survival are improved (White et al., 1996). To ensure that weak piglets are consuming enough nutrients, assisting the piglets to start suckling or supplementary colostrum or milk may be advised (Kirkden et al., 2013).

As soon as the piglets are born they have a strong attraction to the sows udder, mostly due to the warmth and their well-developed sense of smell (Alonzo-Spilsbury et al., 2007). The problem often starts when the litters are too big. In that case there will often be a strong competitive behaviour between the piglets to access the teats, often resulting in weaker smaller piglets because they are left out (De Passille & Rushen, 1989). New-born piglets with higher birth weight has a faster suckling pattern than those with lower weight (Guro Vasdal, Ingrid Østensen, & Inger Lise Andersen, 2011). Smaller piglets will stay closer and seek to the udder apart from the sows nursing and lactation periods, which leaves them exposed and in increased the risk of crushing (De Passille & Rushen, 1989).

The new-born piglets has only a limited capacity of glycogenesis. In the practical aspect this means that if they fails to suckle and starve, they will become hypoglycaemic within 15 to 20 hours after birth. This can happens due to the piglet's failure to maintain blood glucose gained from the lactose in the colostrum. Such hypoglycaemia will cause metabolic disturbance,

impair the chemical thermogenesis and might eventually lead to metabolic acidosis in the neonatal piglet (Alonzo-Spilsbury et al., 2007).

Failure to access enough colostrum and milk cannot be put on the piglets alone; MMA (Mastitis, Metritis and Agalactia) or PPDS (Postpartum Dysgalactia Syndrome) are important diseases of the sow, and therefore common contributing factors. Mammary gland diseases are caused by a bacterial infection, often due to bad hygiene. The bacteria's often enter through the open teat canal after suckling or due to injuries from the piglets teeth or nails when fighting for a nipple (Kirkden et al., 2013). When the lactation decreases or stops, one or several weaker piglets are observed due to starvation (McGlone & Pond, 2002).

To prevent starvation cross-fostering, cross-nursing or artificial rearing is commonly performed. It is important that these procedures are done quickly after parturition to ensure adequate colostrum and milk intake of each piglet (Dyck & Swierstra, 1987).

#### **4.3.2 Hypothermia**

After parturition excessive hypothermia might occur due to low body weight, reduced viability, severe environmental conditions or intrauterine asphyxia (Alonzo-Spilsbury et al., 2007). Piglets with less vigour will struggle to get an adequate amount of colostrum, and as the new-born piglet is poorly insulated, they are highly dependent on the energy and warmth from the milk to survive (J. Le Dividich & Noblet, 1983).

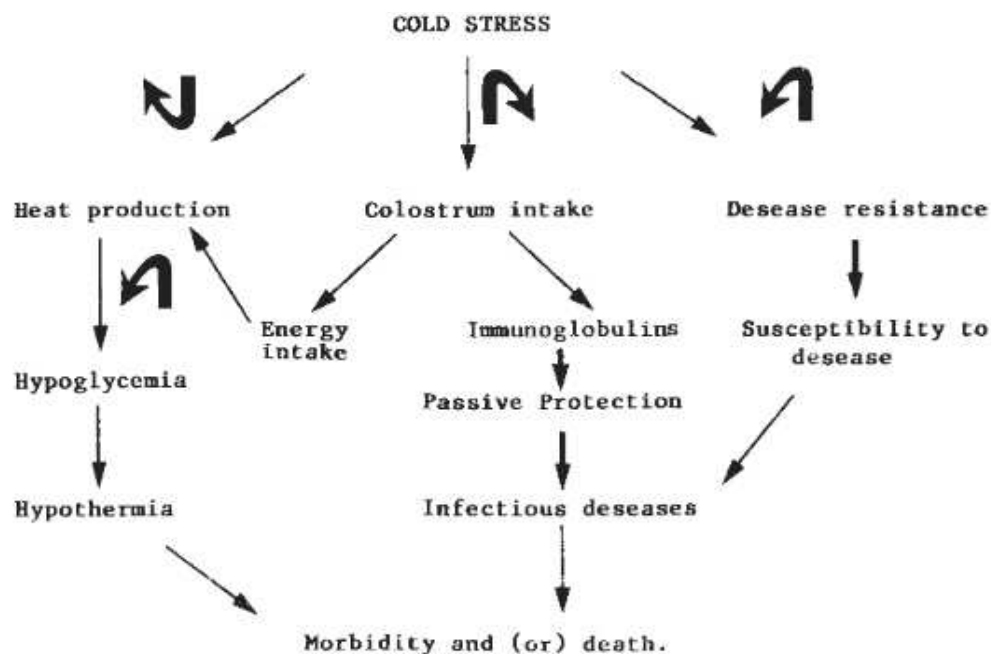
At birth the piglet's rectal temperature drops between 2-4 degrees and it can take up to 24-48 hours to achieve a normothermic state (Alonzo-Spilsbury et al., 2007). This hypothermia is mainly due to the evaporative cooling of the placental fluid (White et al., 1996).

The new-born piglet is born with very little amount of adipose tissue and must therefore rely almost exclusively on shivering thermogenesis when meeting a cold environment (Alonzo-Spilsbury et al., 2007). It is therefore essential to provide an appropriate environmental temperature for the piglets. On the practical aspect this leads to a conflict with the heat requirement of the sow due to the fact that adult pigs are very heat sensitive animals. The environmental temperature in farrowing departments is often set to 16-22 °C, which is the optimal temperature for the sows, in contrast the optimal temperature for piglets are 30-34°C (Guro Vasdal et al., 2011). The farmer's solution to this is the heated piglets corners. The

problem occurs during the first hours after birth, when they are wet, cold and trying to locate the udder.

The piglets own prevention of heat loss is mainly achieved by behavioural adjustments that includes postural changes, huddling and piloerection. In practice this relates to piglets crawling up together close to the udder, seeking heat and protection from the sow. Finding that neonatal mortality is inversely related to the time spent by the dam, disposes the piglets to get overlaid and crushed (J. Le Dividich & Noblet, 1983).

**Fig. 2. Cold stress**



*Schematic drawing illustrating the possible effects of cold on the health of neonatal piglets. Adapted from J. Le Dividich and Noblet (1983)*

On the practical aspect of management the farrowing pens is designed with a heated piglet corners. Placing the piglets under a heating lamp immediately after birth has been proven to decrease mortality up to 50% (Kirkden et al., 2013). If drying (ex. with straw, paper or towels) and massaging is done too, even further decrease can be observed because this will stimulate the peripheral blood circulation and thereby increase sensible heat loss from the skin (Bøe, Andersen, & Haukvik, 2009). Providing straw is also indicated as an effective way to

reduce hypothermia, especially in loose systems. Deep straw creates a warm microclimate which also absorbs fluids leading to a drier environment in the pen (Kirkden et al., 2013).

### **4.3.3 Asphyxia**

Oxygen deficiency is one of the major causes deaths, occurring prior to or under parturition. Since piglets are polytocous species they are more likely to suffer from asphyxia due to cumulative effects of successive uterine contractions. Such uterine contractions will reduce the oxygenation to the foetuses (Alonzo-Spilsbury et al., 2007). This poor blood supply through the umbilical cord increases the risk and predisposes to asphyxia either by twisting, tearing or clamping blood coagulation of the uterus. Other explanations could be a defect or premature detachment of the fetal membranes. Oxygen deficiency caused by disturbances in the sows circulation is less likely than the previous mentioned factors (Rootwelt, 2010). The irregularity of vigour in the litter can also be explained by the interruption of oxygen flow during birth. Although asphyxia in utero and during delivery not necessary leads to stillbirth, it could certainly weaken the piglets and lead to death in the perinatal life. For example is it proven that neonatal asphyxia delays the first contact with the udder and thereby reduces the intake of colostrum (Alonzo-Spilsbury et al., 2007).

On the practical aspect, clearing of the nose and nostrils for mucous is an easy way to improve the first breathing and oxygenation in new-borns, especially in weak piglets (Kirkden et al., 2013). Massaging, for example when drying after birth, will also help stimulating the respiration. Administering oxygen (through facial mask or oxygen chambers) or artificial ventilation increases the vitality of the piglets, but this is considered to be a rather energy consuming procedure. In a study done by Kirkden et al. (2013), they concluded that administering oxygen to all piglets, small or large, decreased the mortality the first 24 hours with 75%.

### **4.3.4 Piglets diseases**

Piglet diseases may include both infectious and non-infectious conditions. Infections often appear due to injuries, especially through wounds on legs and feet's. These injuries are common because of abrasions from the floor when they are suckling or if the sow tramples on them. Wounds might lead to systemic infections and the weak and undeveloped piglets are predisposed (Kirkden et al., 2013). Wounds or castrations can function as a perfect

predisposing factor for entrance of bacteria's leading to altered general conditions. Other complications reported are abscesses, arthritis, irritation/inflammation, streptococcus infection/sepsis (Fredriksen et al., 2009). Therefore acquisition of passive immunity through colostrum milk shortly after birth is considered to be of major importance to reduce mortality (Bøe et al., 2009).

Management strategies to control and reduce the incidences of diseases are important investments in the farrowing period. All-in-all-out management and hygiene measurements, monitoring of piglets and sow, fostering, thermal regulation and frequent cleaning are of high importance. If lameness or wounds are discovered medication, often antibiotics, are used to prevent further infections (Kirkden et al., 2013).

#### **4.3.5 Increased litter size and differences in birth weight**

In the 1990's Danish swine producers started the genetic work to increase the fertility among their breeding sows. The goal was to increase the numbers of piglets per litter (Jøsang, 2011). Today the litter size continues to increase due to the use of prolific sows. Because of this breeding regime there is a greater need for good management practises and skilled stockmanship to keep piglet mortality levels down (Kirkden et al., 2013). Earlier 10 piglets in the first litter was considered good, today 14 piglets is the main average (Jøsang, 2011). The increased focus on genetics and breeding has resulted in improved birth production rates, but not without adverse effects. We are experiencing a lower average birth weight of the piglets (Alonzo-Spilsbury et al., 2007) and the accompanying negative effects, leading to a higher mortality rate (Jøsang, 2011). Increased litter size is negative both for time spent and amount of milk consumed during suckling, and the fact that increased litters often results in small and underdeveloped piglets at birth (Guro Vasdal et al., 2011). Studies has shown that small piglets from large litters has a smaller chance to survive the first days (Rootwelt, 2010). Big litters makes it more difficult for the sow to take care of the piglets that leads to increased losses, especially due to crushing (Andersen et al., 2005). The optimal number of piglets the sow is able to take care of by herself is estimated to be 10-11 in average (Rosvold et al., 2007)

The reason for the degree of variation in birth weights within one litter is due to different locations and nutrient supply to the individual foetuses in the placenta (Litten J, Drury P, Corson A, Lean I, & Clarke L, 2003). The following research has concluded with the fact that



lower birth weight and the lack of uniformity among litter-mates is a risk factor for the survival rate (Alonzo-Spilsbury et al., 2007). This is related to the competitive behaviour of the piglets seen during suckling. The smaller piglets are not able to access the preferred anterior teats and will be fighting in the posterior part trying to access the best or at least a functional teat. Feeding is then rather energy consuming because of the fighting and less milk will be consumed (De Passille & Rushen, 1989). Even at a litter size of 12 piglets there is an average of one piglet which is not able to access a functional teat (Rosvold et al., 2007). Increased litter size is also proved to increase the time interval between parturition and the first suckling, which is an disadvantage in itself (Guro Vasdal et al., 2011).

Both litter size and individual features of the piglets will influence the survival rate, together with the effects and routines around farrowing that will be reduced in the larger litters (Guro Vasdal et al., 2011). The practical solution with too big litters is to perform what is commonly termed fostering or cross-fostering. This management measures are performed to prevent starvation by even out the litters and to increase the competitive ability of the smaller piglets (Kirkden et al., 2013).

#### **4.4 Maternal behaviour**

Maternal behaviour is an important factor related to the loss of piglets. It is also a very individual feature and can therefore be very difficult facilitate (Nowicki & Schwarz, 2010). Her capability to express natural instincts during the farrowing process contributes to the maternal behaviour, nursing and protection of the piglets, especially in loose farrowing systems (Andersen et al., 2005). Good maternal characteristics are classified as a sow able to perform natural nest building, communicate well with the piglets, quickly responds to the piglet's scream, calm and controlled postural changes and a relatively consistent nursing, rest and activity pattern (Andersen et al., 2005). As an example, it has been proven that non-crushing sows has a significantly increased nest building activity than those sows with higher incidence of crushing (Inger Lise Andersen, 2005). Providing nest material, such as straw, may be an efficient way of reducing the risk of crushing associated with rolling, because nest material can play a part in altering this behaviour (Nowicki & Schwarz, 2010). Providing suitable bedding material and arrange for nest building activity before farrowing may reduce stress and decrease the duration of parturition, which both are risk factors to stillbirth (Kirkden et al., 2013).

Most piglets are crushed during the postural changes, especially the transition between standing up, lying down, sitting and rolling are critical (Vieuille, Berger, Le Pape, & Bellanger, 2003). The rolling pattern can be divided into three categories according to Danholt, L. et al. (2005):

1. Rolling udder to side with protected sloped wall of the pen
2. Rolling udder to side without protected sloped wall of the pen
3. Rolling from the side/lateral decumbency to sternal position

Rolling from udder to the side without protected sloped walls (2) has a significantly higher incident of crushed piglets than rolling from udder to side near slanted wall or piglet protection rails (1) and rolling from side to udder (3) (Danholt et al., 2011). In a study done by Jacek Nowicki and Tomasz Schwarz (2010), it was stated that the rolling behaviour was slightly higher in crated sows than in penned sows.

There are also a connection to the litter size and the sow's ability and willingness to nurse. If there are too many piglets the sow may start an ignoring behaviour with the intention reduce the litter size. She may start to be unresponsive to the piglet's screams, resulting in crushing. Stress and lack of ability to express natural instinct may also lead to the same behaviour, often with a fatal end result and maternal infanticides (Rosvold et al., 2007).

Breeding and genetics deserve an increased focus when it comes to expression of natural maternal instincts and piglet crushing. Genetic selection based on maternal behaviour may be advantageous. The same focus should be paid in the development of farrowing pens (Kirkden et al. 2013).

#### **4.5 Loose pen vs. farrowing crates**

According to the Regulation 2001/88/EC of 23 October 2001 amending Directive 91/630/EEC laying down minimum standards for the protection of pigs, the following are stated for the sow keeping at the time of farrowing (PigSite, 2003):

- In the week before the expected farrowing time sows and gilts must be given suitable nesting material in sufficient quantity unless it is not technically feasible for the slurry system used in the establishment.
- An unobstructed area behind the sow or gilt must be available for the ease of natural



or assisted farrowing.

- Farrowing pens where sows are kept loose must have some means of protecting the piglets, such as farrowing rails.

The way of keeping the sows and piglets during the critical period of farrowing and lactation are shown to be very important, but there will also always be an economical question. Hygiene and working conditions will always be taken into consideration (Andersen et al., 2005). Today there are two different systems mainly operating in Europe; loose systems and farrowing crates. The farrowing crates were originally introduced to reduce piglet crushing (Alonzo-Spilsbury et al., 2007). In some countries farrowing crates are banned, like in Norway. In loose systems preventative measures are taken to reduce the crushing and trapping by slanted walls. Either way its important to know the fact that most piglets are crushed centrally in the pen (Andersen et al., 2005), so the piglet crushing remains the predominant cause of death in both the crates and pens (Danholt et al., 2011).

Since neonatal mortality and crushing is in strong correlation with the maternal behaviour, the design of the pen is of great significance. Jacek Nowicki and Tomasz Schwarz demonstrated that sows housed in crates were more aggressive to their newly born piglets. They were also more nervous during the parturition than the sows housed in farrowing pens (2010). With a layout that encourage the sow natural instincts, the piglet mortality can be reduced (Andersen et al., 2005). Restlessness, more frequent position changing and more sitting may be indicating discomfort in the sow. This behaviour is more commonly observed in sow`s housed in farrowing crates than in the loose systems. The result may be higher incidences of piglet crushing (Nowicki & Schwarz, 2010).

#### **4.6 Photoperiod influence**

According to the Regulation FOR-2012-06-28-690 §14 (Landbruks- og matdepartementet, 2003), animals shall be placed in an environment assuring daylight and provide adequate amount of illumination when the daylight are not sufficient. The light intensity shall be at least 75 lux 8 hours a day. It is prohibited to provide artificial illumination of swine permanently. This does not include the use of warming lamps (Landbruks- og matdepartementet, 2003).

Recently there has been focused on extending the daily photoperiod as a factor to decrease pre-weaning piglet mortality in commercial farms. Previous research shown that piglet survival and weaning weight could be enhanced by providing 16:8 (light: dark) hours of light compared to illumination only when feeding and during farmers work time (McGlone, J. J., Stansbury, W. F., Tribble, L.F. and Morrow, J.L., 1988.). This is not in correlation with the study performed by McGlone et al. (1988), which concluded that it had no effect on piglet survival. Neither did Stevenson (1983) agree. In this research it was proven that supplemental light may increase the litter weight, but on the other hand it has no influence on the litter size, number of weaned piglets or the survival rate. The improved litters weight is most likely a result if of the increased milk production, which again can be explained by increased photoperiod (J.S Stevenson, 1983).

Another theory is the influence of increased photoperiod on the natural esturs cycle of the sow. In other species like the ewe and cow, milk production and lactation is influenced by the hormone prolactin. Prolactin is influenced by light so increased exposure to light might increase the concentration of prolactin in the sow which as a secondary effect will lead to a rise in the lactation level. This theory needs more research, but if it turns out to be proven, increased milk production may enhance piglet survival by decrease starvations and its negative effects (Mabry., Cunningham., Kraeling, & Rampacek, 1982).

As far as my research is concerned there are little relevant research on this topic in regard to my thesis.

## 5 Materials and methods

The most integral part of this thesis is based on finding relevant information and facts in literature review, as well as performing my own research study in the fieldwork. My research consisted of testing whether keeping the roof light on the first week after farrowing could help reduce crushing and piglet mortality rate. The theory behind is to see if sows visual orientation would be improved and she would get a better overview of the piglets during postural changes and thereby crush fewer piglets. My methods during fieldwork consist of collection information from observations, clinical exams, direct measures and recordings and interviewees of the farmer before and after the experiment. I performed my practical work during two periods; January and February in 2014 and in 2015. These include 4 farrowing cycles altogether.

The fieldwork was performed at a combined swine practice placed in Re, Norway. Re is located southeast in the country, 1 hour south from the capital Oslo. I did the major part of data collection directly at animal level and by using of Rustan farms own recording system, Ingris (national recording system provided by Nortura). The farmer gave me access to these files and provided me with the records. These would include parameters such as feeding history, disease e.g. MMA (Mastitis, Metritis and Agalactia), piglet mortality, information from the time when I was not around, history and specific records from the facility.

My work consisted of testing my hypothesis regarding the nightlight and comparing the weaning rate to see if illumination is one factor that can decrease the piglet mortality and increase the weaning number. Altogether there where 173 litters are recorded in the two periods of fieldwork, excluding the reference year 2012-2013 with 78 litters.

### 5.1 Production at Rustan farm

Rustan farm has an average livestock of 1200 pigs, whereas 130 of them are breeding sows. The production rate has an annual average of 3400 pigs on a yearly basis and is thereby classified as a large farm in the Norwegian agriculture. The piglets born at Rustan will be sold as growers or stay and fed for slaughtering. The sows are bought as gilts from an approved breeding facility organized by the swine genetic company, Norsvin. Norsvin was established in Norway in 1958 and is owned by the farmers themselves. Their aim is to specialize in

genetic advancement to benefit the pork producers, the meat industry and the consumers. Norsvin's genetic program work to ensure an effective, healthy and robust pig that will perform in a variety of different production environment such maternal factors, feed efficiency and growth of the piglets (Norsvin, 2013).

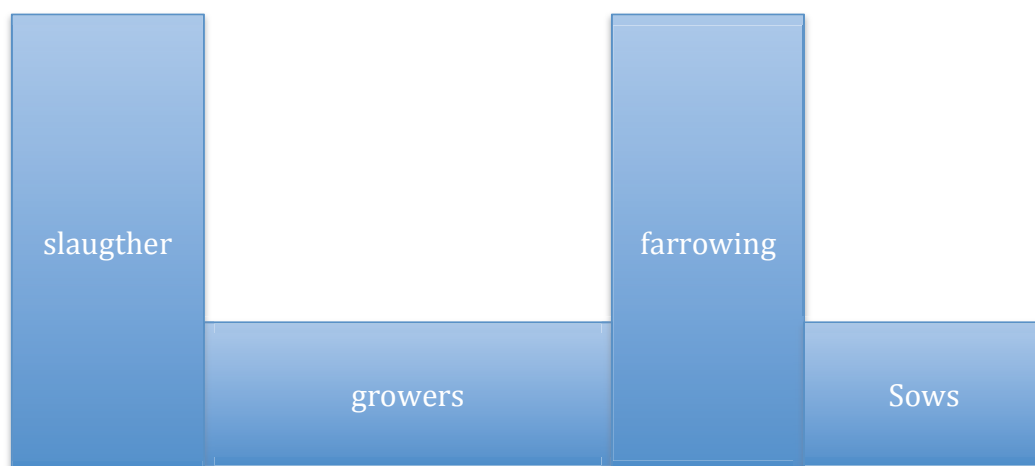
The sows are a combination of Norwegian Landrace and Yorkshire, while the semen is sent from an approved boar station and is a purebred Duroc. This will produce hybrid piglets, which is called Edelgris or Noroc.

## **5.2 Rustan`s farm keeping system**

The housing on Rustan is divided into 7 compartments, whereas two of them are used for farrowing. A concrete wall again divides the two farrowing departments. This is where I performed my research. When the sows are not stabled here, they are placed in other compartments during insemination and the gestation time. All of the animals are kept in loose systems. Tied and created systems have been forbidden in Norway since 2000 according to the FOR-2012-06-28-690, § 8 (Landbruks- og matdepartementet., 2003). During the gestation period they are housed in larger pens (8x7m) with ca.12 other sows, all in the same oestrus cycle. Approximately 1 week before farrowing they are moved to one of the two farrowing compartments and installed individually in loose system pens measuring 2,4 x 3,6m. Both of these compartments can maximally house 33 sows each. When there are weaning in compartment there will be farrowing in the other.

Each farrowing pen are designed, as in correlation with the legalisation- FOR-2012-06-28-690 Paragraph § 8 (Landbruks- og matdepartementet.,2003), to optimize the situation of sow and piglets throughout the first 10-11 weeks of life. There are installed floor heating and a heating lamp in each piglet corner. The walls are slanted or installed with rails for prevention of piglet entrapment and crushing. The floor is painted with a special mixture giving the floor an anti-slippery texture. This also covers the sharp texture of the concrete to try to protect the sow from bedsores and the piglet's carpus while fighting for a teat. Water nipples are arranged in 3 different heights and there is a trough placed so the piglets can learn how to drink. The feeders are placed on the floor; there will also be an additional trough in the piglet corner for the starter feed.

**Fig. 3 Rustan farm**



*Illustration of the pig house and it's departments on Rustan farm.*

### **5.3 Light provisions on the farm**

The Rustan farm provides light from two different sources in the barn; natural light through windows and artificial light through fluorescents bulbs. The farrowing departments have additional illumination from the heat lamps in the piglet corners. The artificial lighting is placed along the ceiling in two lines throughout the department. There are windows installed along all the exterior walls of the barn. Natural lighting is very variable according to the seasons in Norway. Artificial lighting is only provided on Rustan when the workers are present, typically during feeding or cleaning. This corresponds to illumination approximately from 7.00-11.00 and 15.00-16.00 on a daily basis. During my fieldwork, November-February, the daylight darkness ratio contributes to an average of approximately of 8:16. This means that the litters born during this period is exposed to more dark hours than lighted. During my research there is artificial lighting provided 24 hours a day for 7 days or until all sows has farrowed and 3 days after that.

### **5.4 Cycle**

This farm runs a 5 1/2-week breeding cycle, which means that the piglets are weaned at an average of approximately 33 days. These piglets will stay in the same department they are born in until weaning and for approximately 4 more weeks. After this period they will be moved to the growers department or sold. Rustan performs the all-in-all-out method before

each input. The department will then stay empty while being cleaned, disinfected and dried up, before a new set of farrowing sows are moved in. At weaning the sows are then removed from the farrowing department and either goes to the stalling for insemination or for slaughter. A few sows (1-2) will be kept with their litter as fostering/caring mums for the next farrowing group in case some of the litters are too big or if a sow dies. The sows normally get in heat within 5-7 days after weaning, which contributes to the 1<sup>st</sup> week of the cycle.

**Table 2;** The cycle for one compartment

Week 1	Farrowing and insemination of sows in weaning heat.
Week 2- week 4	
Week 5	Weaning and removing sows.
Week 6- week 9	
Week 10	Piglets are removed to growers department or sold. Cleaning, disinfecting and drying. After drying, input of farrowing sows.
Week 11	Farrowing and insemination of sows in weaning heat.

## 5.5 Nutrition

### 5.5.1 Sow nutrition

For optimizing the production rate, the sow's diet is precisely scheduled from where in the cycle they are. Under gestation they are under restricted feeding with a complete pellet mix called FORMAT Drektig (meaning gestation). The food is developed by the Norwegian food company Felleskjøpet, ensuring the best condition during the pregnancy period.

Approximately 3 weeks before farrowing the sows are switched gradually to a fodder developed for the birth period; FORMAT Fødsel (translated: birth). From 5 days before expected farrowing there is a mixing of birth fodder with a lactation fodder; FORMAT Laktasjon. After farrowing they will be fed on this throughout the lactation period. The sows are fed restricted all the way up to the point of farrowing from then they are fed ad libitum FORMAT Laktasjon (meaning lactation).

Sows at all stages are feed hay to provide enough fiber in the diet, with the aim prevent gastric ulceration. It also has an effect to prevent boredom and stimulate the natural behaviour.

### **5.5.2 Piglet nutrition**

The growth of the piglets is in correspondence with the lactation of the sow and her health status. During the first hours of life the farmer makes sure that all piglets receive colostrum. If there is a big litter or very uneven weight of the piglets, cross-fostering will be performed. The first 6-7 piglets will be marked and removed for a couple of hours so the later born piglets will have a chance to receive enough colostrum. There will also be provided extra milk substitutes if the litters are over 14 or there are health issues with the sow.

Piglets start to taste/eat pellets at 1 week and will from that point have access to FORMAT Starter until ca. 2 weeks before weaning. The farmer put the feed in the piglet corner manually to avoid it from being eaten by the sow.

Iron is given orally (normin®FERRO paste) within the first 24 hours of life and as an intramuscular injection (Gleptosil vet.) 4 days later.

2 weeks before weaning they change from starter to a fodder specialised for the critical period of weaning. This is called FORMAT Robust 150 and has the purpose to prevent weaning diarrhoea and oedema disease (<https://www.felleskjopet.no/kraftfor/svin/>). Zinc is given as a substitute powder from the 1<sup>st</sup> day of weaning and for the 14 constitutional days. This farm also provide their piglets with weaning peak (normin-avvennings torv) without iron will be also be given from weaning, but in 10 days after weaning with the purpose to prevent weaning diarrhoea. They will continue to feed peak, but after the 10 days they will give peak with iron added, normin-ferro torv.

## **5.6 Management of new-born piglets**

During the first days of life there is several measures being done to optimize the growth and decrease negative factors such as anaemia, injuries and diseases.

### **5.6.1 Colostrum**

As described in the nutrition part of piglets (Point 5.5.2 Piglet nutrition), it is crucial that each piglet gets enough colostrum. Here the farmer will rotate the new-born piglets with a marking system to make sure that all them receive a sufficient amount. If a sow gets a too big litter, e.g. over 18 piglets, cross-rearing will be performed and some of the piglets will be moved over to a smaller litter. This must to be done within 24 hours before the fostering sow gets inactive teats.

### **5.6.2 Iron supplement**

Iron supplement is routinely given to prevent anaemia and weakness in the piglets. The iron is first supplied orally within the first 24 hours of life and then repeated 4 days later with an intra muscular injection in the neck region.

### **5.6.3 Tooth filing**

As soon as colostrum is assured all the piglets will have their upper and lower canines filed to decrease injuries to the sow teats and to the other piglets.

### **5.6.4 Castration**

A veterinarian performs routine castrations during the first week of life. Castrations are done on male piglets to prevent unpleasant taste and odour in the meat, boar- taint (Prunier et al., 2006). The procedure is done with local analgesia with Lidokel and Metacam injection followed by a simple intervention with a scalpel blade. It considered particularly important to keep good hygiene and clean conditions the time after castration to prevent contamination and to prevent diseases.

## **5.7 Management and factors used to decrease piglet mortality at Rustan**

Several factors are done to prevent and decrease piglet mortality at a practical level on Rustan farm. A good manufacture thru all steps including feeding, keeping and facilitation are needed. First and prior measure is to keep the sow healthy and prepared for farrowing. Their goal is therefore to keep the sow at a favourable weight. To big or overweight sows are more likely to crush their piglets than the leaner ones. Precise and feeding throughout all steps of the gestation is carefully planned by the farmer. Pen size and layout also play a contributing factor too this; the design and proportions of the bin will influence how and where the sows lie down, and also how easily the piglets can escape and prevent being lied on (see 5.2 Rustan keeping and farm system). From the day the sows are placed into the new pen in the farrowing department, they are provided by a sufficient amount of nest building material. Rustan farm uses hay.

During the farrowing there are several critical measures to be taken. To be present is one of them. The farmers routine consist observations during parturition and perform assistance to the sow if necessary. They try to keep a consistent routine to dry and move the piglets under the heated area, but due to other duties on the farm this is difficult to follow up. The farmer will evaluate the sows and the litter. They monitor the sow by measuring her feed intake, examination her udder and taking rectal temperature. The behaviour of the piglets, if they are



unsettled and hungry and/or lies on top of her may indicate decrease in the sow health. The farmers will take necessary measures to decide whether the sow has milk for all, or if she is has good maternity abilities. For example if the litter is very uneven and there are some very weak or small piglets, they will struggle to get enough milk then these piglets can be moved to a litter with fewer piglets or more similar size like themselves. Another example I've experienced on my practice was a sow which lay down on 5 of her piglets, this will be recorded as poor maternity and she will be sent for slaughter after this period.

As well as the practical concerns management factors are also important. The farm is carefully controlling the temperature in the department according to the season. This concerns for adjustments to optimize the temperature for both the sow and the piglets. The farm has a ventilation system, which ensures proper airflow and heat exchange. In case of defect on the system, the farmer is informed due to alarm system connected to his cell phone.

During my research there where no change in the routines, nutrition or other procedures. Neither did they change or ad new factors which may have contributed to my result.

## **5.8 Registration and recording systems**

Rustan farm works in cooperation with Nortura and Norsvin. Nortura is the slaughterhouse company providing the farm with relevant information and evaluation systems on their carcass and health measurements after slaughtering. These protocols provide results and statistics on the farms own production level, from the same community and on national level. Norsvin functions, as mentioned before (4.1 Production), as cooperative breeding adviser. They perform research on both national and international level since they work cooperatively with Topigs providing a global network. They have also developed a recording system called Ingris. Ingris is a database where all production results can be stored and set up statistically, controlled and compared to other swine facilities in Norway. They are also able to compare the national records to other countries, Denmark and Sweden for example.

## 5.9 Data collection

My research has been based on testing my hypothesis whether the light is influencing the crushing by testing if keeping the light on during the night would decrease the mortality rate caused by crushing.

As I would get best results on lightning-control research when the environment is dark, I recorded the data in the two periods during two consecutive winters when the daily hours of darkness reached its highlight. First period of fieldwork was performed November 2013 to February 2014. This recording included two birth periods with the 5th week in the cycle. I repeated the same measures with two cycles in November 2014 to February 2015. I did this fieldwork in comparison with results from the same timeline in 2012-2013.

For the literature review, my work is based on finding relevant and reliable data according to my topic. I mostly relied on information from journals and electronic articles, but also the web pages of Nortura, Norsvin and Felleskjøpet, which are the cooperative partners of Rustan farm. I was given access to the member pages where relevant information and literature were written. On the private pages I had access to Ingris (5.8 Registration and recording systems).

When searching for relevant articles I connected to the network of Szent Istvan University library through my private virtual network. In this manner I could access relevant articles while working from home in Norway. I used several databases in this part of my work such as Pubmed, Applied Animal Behaviour Science (Official Journal of the International Society for Applied Ethology) and Google. The keywords for my search were “stillbirth of piglets”, “crushing of piglets”, “piglet mortality” and “pre-weaning mortality of piglets”.

I also found it very helpful to search in the reference list of those articles that I used. In this manner I collected several new articles and information that were useful for writing the literature review.

## 5.10 Management of questionnaire

**Table 3:** Before recording period

1	What is the assumed percentage of crushed piglets at this farm facility?
2	What measures are done to prevent crushing of piglets on a regular basis?
3	Is there any time of year you feel there is a remarkable difference in crushing of the piglets. If yes, when?
4	Is there any remarkable difference in the sows regarding crushing? a) With the age? b) With the size? c) With the number of litters? d) With the litters size? e) With the piglet size (small, weak, big, mixed)
5.	Is there anything you could do better to decrease piglet crushing?

**Table 4;** After the recordings

This are the main questions I was left with after my research.

1.	Have any management factors been changed during the timeline of recording including 2013-2014 and 2014-2015? If yes, what have been done?
2.	Have there been any change regarding the nutrition during the timeline of recording including 2013-2014 and 2014-2015? If yes, what has been changed?
3.	Have there been any diseases during the timeline of recording including 2013-2014 and 2014-2015? If yes, which?
4.	Has there been any other factor that might have changed during the timeline of recording including 2013-2014 and 2014-2015?

## 6 Results

The results from my research speak in a positive manner for decreasing pre-weaning piglet mortality at Rustan farm. From my recordings there is a marked increase in the weaning-rates on both years. Before I performed this research, Rustan farm had an average piglet mortality rate of 16,1 % from 2010-2013 (Ingris report). From my reference year the rate was 16,7%. This is in the upper scale of what is the average in Norway.

The farm performs several of the advised measurements to decrease piglet mortality, but as Lars Kristian Rustan stated during my first interview, this is highly dependent on the presence of other duties on the farm. Normally, if they are present, they try to dry all the piglets with hay and place them under the heated piglet corner. They also try to keep good sow health by providing stimulating nest building material, appropriate nutrition and temperature measurements after parturition (see point 5.5.2 and 5.7). There is always something they could do better Lars Kristian Rustan says and to find the key points which is both doable and effective. For example prioritize and facilitate for better environment, such as hay and bedding continuously in the piglet corner, drying of all piglets and clean the nose and mouth for mucous after birth. The problem is to find economically and time favorable measurements, which also provides good and makeable results.

Even though some preventative measures are performed, the farm experiences an increase in the mortality rate at during the summer (most likely due to heating stress of the sow) and a rather constant increase during the winter. The lowest mortality is seen during spring and autumn. Lars Kristian Rustan states in the interview that the farm can confirm an increased mortality and crushing rate in large litters, especially if the piglets are of variable size and vigor. The sows health play a significant role too. At Rustan farm they try to keep them at an optimal weight, not too thin neither too thick. From their experience they believe that an overweight sow tends to crush their piglets more frequently than normal weights. Older sows also tend to be more tired and have lower patience with the piglets and therefore crush more piglets.

There was no change in management, routines or nutrition during the years of my research that may have influenced my results according to Lars Kristian Rustan. The only factor he knows has been changed in the bedding material in summer 2014, where the farm changes from a fine cut saw dust to wood shavings.

For my research I gained results through the recording system Ingris. I evaluated the most significant number with respect to my thesis. These recordings represent the average number from my practical periods.

**Table 5; Result from my research**

	<b>Reference:</b> 01.11.2012- 28.02.2013	<b>Fieldwork</b> 01.11.2013- 28.02.2014	<b>Fieldwork</b> 01.11.2013- 28.02.2015
Number weaned litters	78	89	84
Average number of live born pr. litter	14,8	14,5	13,7
Average number of stillborn pr. litter	1,2	1,1	0,9
Age at weaning	38 days	35 days	34 days
Percentage of deaths until weaning	16,7%	13,6%	14,3%

*These measurements are adapted from Rustan farms own recordings (Ingris,) which distribute the pre-weaning mortality rate from the specified periods.*

As demonstrated in the table there is a marked decrease in the mortality rate from the reference year and the periods of fieldwork. The first year displays a result of 13,6% in the pre-weaning mortality rate. This contributes to a decrease 3,1% in difference to the reference year. On the second year we see a slight increase in mortality rate (14,3%), but it is still a 2,4% below the 16,7% from 2012-2013. This result indicates that providing artificial illumination during dark periods may be a promising factor to decrease neonatal mortality the first days after farrowing.

For the result to be considered completely valid it requires significantly more research and study. There are several possible sources of error that need to be taken into consideration were I didn't have the knowledge or recourses to perform.

## 7 Discussion

The high intensity on swine production has resulted in high pressure on both farm management, economical issues and animal welfare, and in spite our current knowledge on prevention of pre-weaning mortality of piglets, it still remains a major economical and welfare issue (Alonzo-Spilsbury et al., 2007). It has been shown that the most significant factors regarding the reduction of piglet mortality are the farmer's own routines and efforts around farrowing. Their presence, observations and managements around are crucial, but it will also require more educated workers. For adjustment to be made, it's important that they are simple and not too time consuming.

Providing artificial illumination in otherwise dark surroundings, fulfill all these requirements. This procedure is economically favourable since one can use the already existing light sources on the farm and it does not require any previous knowledge. The feasible simplicity speaks for itself. It should though be performed in correlation with the regulations (FOR-2012-06-28-690 §14) and ensure animal welfare satisfaction.

The positive results from this research exposed a decrease of 3,1% in the mortality rate the first year and 2,4% the second year in difference from the reference year with 16,7 %. This indicates that providing artificial during dark periods, the first days after farrowing is a promising factor to decrease neonatal mortality. Although the effectiveness cannot be completely relied on, further investigations are required to evaluate to determine whether the procedure is valid. Other management factors will still be necessary to perform to ensure good animal welfare and a safe decrease in the mortality rates.

One of the most important facilities and management procedures are the piglet corners installed in the farrowing pens. The theory states that placing the piglets under a heat-lamp will decline the mortality significantly. Even further decrease will be seen if the piglets are dried and massaged before because this will help stimulating the blood circulation and potentially reduce the heat loss. What I often experienced during my practice is that only a few piglets are actually using the heated corner the first two days. It seems that their natural instinct and attraction towards the sow is overcoming the facilitated warm and dry corners. Although drying and placing the piglets under the heated corner will potentially spare a lot of energy and decrease the heat loss in the rather energy consuming firsts attempts to walk and search for the udder. This energy spared will be well needed in the fight for a teat and vital

colostrum, especially for the last piglets born in a relatively large litter. In combination with the practical aspect that it is so easy to perform this procedure, it will depend on the willingness of the farmer because it does take some time to dry off and massage every single piglet. Rustan farm was more consequent on this procedure with the last piglets in the litter. The last-born piglets were according to them the smallest and potentially weakest piglets and were more dependent on external helping factors.

Providing milk replacers in all pens with either too big or uneven litters or decreased general condition of the sow to prevent starvation. This was not commonly performed on Rustan farm, unless, a sow died during the lactation period or a litter were too big. The positive with this procedure is that it is easy and requires only minimal knowledge and experience by the farmer, but might require some time to learn the piglets how to drink, although they seemed to get it quite fast. This will depend on the farmer's efforts, but it requires a relatively short time span to perform in contrast to other procedures such as providing extra oxygen with a facial mask, administering fluids to dehydrated piglets or injecting colostrum or milk-replacer orally immediately after birth. On the negative side if some of the small piglets will never access any milk from the sow, they might experience lower growth rate on these piglets.

Cross-fostering or nurse-fostering are procedures with very positive results. This is done to even out the big litters to prevent starvation. On the other hand it has to be done within 24 hours as (according to Lars Kristian Rustan) some of the sow's teats may turn inactive if not used. This procedure is also commonly used if the sow is ill or dies.

An individual evaluation of the litters will give a good indication on which management procedures that should be performed. Often will a combination of several factors give the best results. It is also important to keep in mind and facilitate the primary preventative factors as basic measurements, such as room temperature, cleaning, bedding and general health status.

## 8 Conclusion

It has now been proved that the most crucial and feasible factors done to prevent pre-weaning piglet mortality are those that with economical benefits, which are not too time consuming and only require a certain amount of knowledge. Focusing on those routines that are most likely to give the best result, while also being practically easy to accomplish, will contribute to giving the highest success rate. Often is a combination of basic preventative measures together with several of the practical procedures the most effective to reduce the mortality rate.

The results from my research indicate that providing artificial illumination during dark periods may be a promising factor to decrease neonatal mortality of piglets.

As far as my research is concerned, my results from research of photoperiod effects on piglet survival and crushing could not be interpreted effectively. Further more research is needed to consider the results completely valid, although this is a good indicator for a positive factor to decrease piglet mortality.

The overall goal should be to minimize the human interference and facilitate for the sow to be able to nurse and wean a larger litter and be independent of external helping factors. For this to be accomplished we need to focus and improve our breeding goals and genetics, optimize the farrowing pens and facilities and provide necessary material to stimulate natural maternal behavior.



## 9 Summary

Neonatal piglet mortality contributes to major losses in modern swine production. This regards for both economical and welfare issues. There are several contributing factor to take into consideration, such as genetics and breeding, management and routines at the farm. The best preventative measures are those that handle the actual cause and background of these deaths, and are acting in accordance with the pig's natural instincts. The most common causes of pre-weaning piglet mortality are related to the crushing of piglets; starvation, hypothermia, hypoxia, to big and uneven litters and the sows behavior. These are often considered to be primary factors with increases the risk and danger to crushing.

Good management factor solutions are contributing to a better environment for both the sow and the piglets. Loose farrowing systems and providing the sow with nest building material will help the stimulation of natural maternal instincts and decrease stress. The pen should be facilitated with a protected and heated piglet area preferably with good bedding or hay. To have a slanted or railed pen might to prevent entrapment of piglets against the wall, although its been proven that most piglets are overlaid in the middle of pen.

The most critical period regarding neonatal mortality of piglets is the following 48 hours after parturition. This is the time when the piglets are building up their vigor and strength, and are therefore most sensitive and exposed to environmental factors. Most piglet crushing's occurs in this timeline. The sows health and general condition is also most sensitive during this period. A sick or stressed sow show significantly decreased maternal abilities.

The farmers effort, presence and routines during farrow and the critical following days are very important regarding reduction of pre-waning piglet mortality. One of the most important factors is to dry and massage the new-born and then place them in the heated area. This would give the piglets a safe start and better their opportunities for survival since their heat loss will be decreased and more energy will be spent in the fight for the vital colostrum.

The farmer should evaluate each litter individually and perform cross-fostering or cross-nursing if necessary, to even out the litters. If this procedure is not possible, additional milk replacers should be used to prevent starvation. Maternal ability should also be taken into consideration, especially in the decision for re-insemination.

The management procedures done to prevent piglet mortality are most successful if they are simple, require less knowledge and are not too time consuming. Providing artificial illumination fulfill all these demands, plus being economically favorable. The theory states that providing light might help the sow and piglet's orientation and sight, and thereby potentially reduce piglet crushing. Although this theory speaks in a positive manner according to my results, it still needs further study and thoroughly research to be completely valid.

Ideally, a combination of several of factors should be implemented to ensure the best and most profitable results against piglet neonatal mortality. Improved genetics, with an ulterior motive on maternal behaviour, litter size and vitality should be performed. Construction and design to optimize the necessary facilities regarding keeping of sow and piglets during the farrowing period. Management factors that focus on animal welfare and which also proves to be favourable both practically and economically for the farmer, are advisable to perform in order to decrease pre-weaning piglet mortality.

## 10 Összefoglaló (Hungarian summary)

A malacok fiatalkori elhullása a modern sertéstartás veszteségeinek egyik fő forrása. Ezen elhullások mind a telep gazdasági helyzetére, mind az állatok jólétére is hatással vannak. Számos tényező játszhat közre a fiatalkori elhullások befolyásolásában, így például az állatok genetikája és tenyésztése, valamint a management és a jellemző szokások a farmon. A legjobb megelőzést ezen aktuális kiváltó okok kezelése jelentheti, amelynek során figyelembe kell venni a sertések természetes ösztöneit is. A malacok összenyomatása a választást megelőzően leggyakrabban az éhezés, a hypothermia, a hypoxia, a túl nagy illetve egyenlőtlen almok és a koca viselkedése miatt jöhet létre. Ezen tényezőket tartják elsődleges okoknak a malac összenyomatás esélyének növekedésében.

A jó management döntések hozzájárulhatnak a jobb környezet megteremtéséhez mind a malacok, mind a kocák közelében. A kocák kötetlen tartása és a fészek építéshez szükséges anyagok biztosítása segíti a természetes anyai ösztönök kialakulását és csökkentik a stresszt. A fiastató kutricákban elhelyezett fűtött és védett malacbújtató, jó alom anyaggal ellátva, szintén jó hatással lehetnek. A lekerekített oldalfalak illetve a ráccsal elkerített malacbújtató segíthet a malac összenyomatás csökkentésében, habár a malacok többsége inkább a kutrica közepén esik áldozatul az összenyomatásnak.

Az ellést követő 48 óra tekinthető a legkritikusabb időszaknak a malacok újszülött kori elhullásában. Ezen időszak az, amikor a malacok szívóssága és életrevalósága megalapozódik és amikor is a leginkább kiszolgáltatottak és érzékenyek a környezeti hatásokra. A malacok összenyomatása is ebben az időszakban a leggyakoribb. A kocák egészségi állapota és kondíciója is ebben az időszakban a legérzékenyebb. A beteg és stresszes környezetben lévő koca csökkent anyai gondoskodásra képes.

A üzemi dolgozók fáradozása, jelenléte, szokásai az ellés során, és az ezt követő napokban nagyban hozzájárulhat a választás előtti malacelhullás csökkentéséhez. Az egyike a legfontosabb tevékenységnek ebben az időszakban a malacok szárazra törlése, masszírozása és azután fűtött helyre tétele. Ez a "beavatkozás" kedvező lehetőséget teremt a malacok életre kelésére és életben maradására, mivel a hőveszteséget így csökkenthető és több energia maradhat a szükséges kolosztrum megszerzésére, felvételére.

Az állatgondozónak minden almot egyedileg kell értékelnie és ha szükséges az almokat dajkásítással kell kiegyenlíteni. Ha ez a lehetőség nem járható, akkor tejpótlóval kell

kiegészíteni a táplálékukat, hogy megelőzzük az éhezést közöttük. Az anyai gondoskodást is érdemes értékelni, hogy az újratermékenyítés kérdésében dönteni tudjunk.

A management-ben jelenlévő megelőző intézkedések a malac elhullás megakadályozására akkor a legsikeresebbek, ha egyszerűek, kevés hozzáértést igényelnek és nem időigényesek. A mesterséges megvilágítás szabályozása megfelel ennek a kívánalmaknak, és gazdaságilag is előnyös. A munkámban közölt teória alapján feltételezhetjük, hogy a több megvilágítás segítheti a koca-malac tájékozódását és látását, ezzel is csökkentve a malac összenyomatás lehetőségét. Habár ez a teória pozitívan hatott a sertésekre és ez az eredményekben is nyomonkövethető, de több és részletesebb vizsgálat lenne szükség ezen megfigyelések pontos igazolására.

Ideálisan több tényező befolyásolásával lehetséges a legjobb és leggazdaságosabb eredmény elérése az újszülöttek elhullásának csökkentésében. Az állatok genetikai tulajdonságainak fejlesztése lenne szükséges az anyai viselkedés, az alomlétszám és a malacok életképességének fejlesztése érdekében. A fiaztató kutricák építését és tervezését is optimalizálni szükséges a kocák és malacok igényeihez. Az állatjólétet befolyásoló tartási körülmények fejlesztése, valamint management döntések meghozatala tanácsolható, amelyek előnyösek mind a gyakorlati, mind a gazdasági oldalról a farmernak a malac elhullás csökkentése érdekében.

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