TN70 FEED MANUAL

Tips and advice for TN70

Global Nutrition and Female Reproduction Services

Updated: 31-01-2023 | Global version

www.topigsnorsvin.com

Topigs Norsvin

1. INTRODUCTION

The aim of this manual is to provide guidelines regarding management and feeding for the TN70 sow based on daily nutritional requirements. Global Nutrition and Female Reproduction Services in cooperation with Topigs Norsvin Research Center collects continuous data of the TN70 sow worldwide and processes this data in our own Topigs Norsvin sow model. The outcome of this sow model determines the guidelines to unlock the genetic potential of the TN70. Beside the daily requirements, we provide practical feed and water, management, health and animal welfare advice for all our markets.

With the continued genetic progress, the nutritional demands of our modern and highly prolific sows also change rapidly. Nutrient supply, in the form of energy and amino acids, must therefore be optimized to ensure a high reproductive performance and maintenance of body reserves throughout a sow's productive life. Diets should also be optimized to ensure nutritional welfare and comfort of the animals, but also minimize the environmental impact through excretions. A precise adjustment of feed composition and level according to the performance level of the sow is thus required.

Good management of the sows is also an important aspect to ensure a high lifetime productivity. In this new version of the TN70 manual we offer advice on management, health, and welfare considerations in pig production, with a special focus on group housing and free farrow systems.

Global Nutrition and Female Reproduction Services would like to thank De Heus and Agrifirm for their contribution to this manual.

Global Nutrition and Female Reproduction Services, 2023

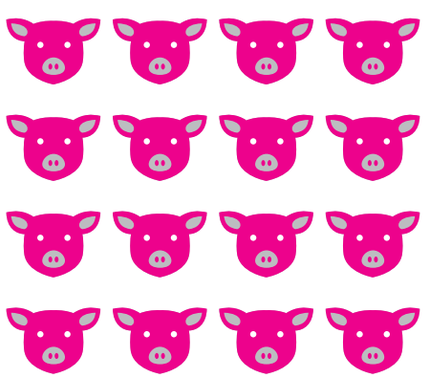
2. THE TN70 SOW

The TN70 sow is a hybrid parent female combining the Large White named as Z-line with the Norsvin Landrace. It is a unique female that combines prolificacy, weaning ability and durability with a top contribution to finisher quality. This sow is a highly prolific and easy to manage sow. Her good maternal qualities and high number of functional teats ensures large and robust litters. With her high contribution to finisher quality, she is the ultimate female for the best Total Feed Efficiency.

The TN70 sow is leaner and has a larger mature body size compared to other Topigs Norsvin lines. She also grows faster, reaches first puberty earlier and is naturally leaner. In consequence, it is important that she has the right body composition at insemination as she needs enough body reserves during her lifetime. Therefore, proper management and nutrition during all stages is highly important.

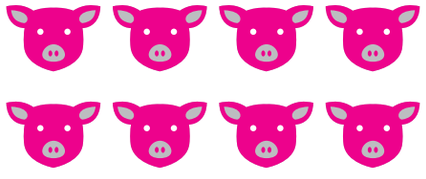
2.1 Production targets

Total born:	> 17 piglets
Live born:	> 16 piglets
Stillborn:	< 8 %
Preweaning mortality:	< 11%
Piglet birthweight:	> 1.3 kg
Piglet weight at 3 weeks:	> 6.5 kg
Weaned per litter:	> 14 piglets
Farrowing rate:	> 90%



Finisher performance

Growth:	> 1000 g/day
Feed conversion (kg feed per kg gain)	< 2.5
Mortality	< 1.5%



Excellent mothering ability

No nurse sows needed

3. ANIMAL WELFARE AND PIG SIGNALS

"The welfare of an animal is its state as regards its attempts to cope with its environment" (Broom, 1986). In other terms, the welfare of an animal depends on its ability to control its environment. It is also a characteristic of the individual animal and varies from poor to good. Domestic animals have different coping mechanisms that they use, including physiological changes in the brain, adrenal glands and immune system and linked to some of these, behavioural changes. Failure to cope with the environment can lead to reduced fitness, growth, reproductive failure, or death. The attempts to cope and the result of failure to cope can be measured, hence welfare can be assessed in a precise scientific way using a variety of indicators (Broom and Fraser, 2007).

Because of their considerable learning ability and their elaborate social behaviour, welfare problems for pigs arise if they are unable to control events in their environment, if they are frustrated or if they are subjected to unpredictable situations. An important part of pig production should therefore be to assure that physical conditions, social influences, and health are as optimal as possible.

Free farrow systems

Group housing and free farrowing systems are the future. The TN70 sow is a self-reliant sow suitable for such systems, but such systems also require a basic understanding of the animal's behavioural needs and how they communicate. It is about using their signals to design production efficient units.

Communication

Pigs are social and communicate mainly through smell, taste, and vocalisation. Odours are very important for communication among pigs in a group, and they use these to send messages to distinguish between individual group members, check social status, age, gender, and reproductive status.

Pigs live in a world of odors. Their sense of smell and taste are highly important for their social well-being.

Intelligence

Pigs are considered smarter and easier to train then dogs, they are also very curios and can work together to solve problems. Pigs have a very good memory, and they have a good overview of their surroundings. Pigs can distinguish between different people, and they can remember who treated them good and who treated them badly.

Behaviour

In the wild pigs live in family groups. The groups develop a stable hierarchy, which to a large extent is maintained by active submission and avoidance behaviour by the animals which are low in the social rank. The group members synchronize their behaviour and will for instance eat, sleep and root simultaneously. Pigs will spend about 70% of their time walking, rooting, and foraging. This behaviour has not changed after 10.000 years of domestication, and their need for rooting is still very much present in our modern pig.

Aggression between pigs is usually due to dominance structure and competition for resources (i.e., food, water, resting area). Aggression towards humans is almost always fear related. Studies have shown that fear level in pigs is negatively correlated to reproductive performance. Scared animals are also difficult to handle, and they can pose a potential threat to stock personnel.

Aggression towards humans is almost always fear related, and a sign of poor socialization with humans.

A sow that barks, opens her mouth, and smacks her jaws when you enter her pen, is signaling that she does not trust you

Fearful sows with a good maternal instinct will always try to protect their young. Luckily, it is easy to form positive social connections with pigs of all ages. Pigs will easily form social attachments to their caretakers if this connection is positive. Pigs that are socialised to man at an early age will be easier to handle when older, and it is positive for overall production performance. Stress is contagious, so stay calm when managing pigs. Be predictable, keep to your routines and spend some minutes every day interacting with the pigs in a positive manner.

In the wild sow leaves the herd when approaching parturition and find a sheltered spot to start building her nest by digging a shallow hole in the ground, and then fills it with bedding material such as grass, twigs and leaves. Even after 10 000 years of domestication the behavioural need to build a nest before farrowing is ever present in our modern sow. Nest building behaviour is largely triggered by prostaglandins. Research has shown that sows will attempt to build a nest regardless of their environment. A sow uses around 12-15 hours to build a nest. It is therefore important that the sow has nest building materials available at least 12 hours prior to farrowing. Studies have shown that sows unable to perform nest building show poorer maternal ability. They communicate less or more negatively with their piglets and respond less to their piglets. Nest building material used under production conditions are straw, saw dust, wood chippings or burlap/jute sack.

Nest building prepares the sow for parturition. Sows able to perform nest building behaviour have increased levels of oxytocin and prolactin, are calmer, have shorter farrowing duration, fewer stillborn and improved maternal behaviour.

Sow-litter communication through vocalisation, sight and nose contact is important. Colostrum intake is vital for piglet survival; thus, a shorter farrowing duration and a calm sow ensures that more piglets get access to a teat earlier. Sows nurse about once per hour and suckling contains a complex signalling pattern between mother and young. This communication is essential for piglet survival and growth. Milk is only available for a short period of time, and a missed meal means another hour without food for the piglet.

TIP
In free farrow systems it is important that the sow has space enough to turn around in the pen allowing her to have frequent nose to nose contact with her piglets. She needs to be able to check where her piglets are and push them aside before laying down.

4. WATER

Water is essential for all life and is the nutrient that is required in the largest quantity by pigs. Water is required for tissue maintenance, body growth, foetal development, lactation, thermoregulation, mineral homeostasis, excretion of metabolites and antinutritional substances, achievement of satiety and behavioural purposes. Water requirements will depend on temperature, health status, diet, age (body weight) and production stage. Water should always be freely available, and easily accessible for all pigs in a group. A low water intake could lead to dehydration, reduced feed intake, reduced milk production, increased stress, more urinary tract infections and a lower tolerance for disease. Poor water access and/or quality is also considered as risk factors for tail biting occurrences and prolapses.

Water should always be freely accessible to all pigs of all ages.
This is not a resource they should need to compete for.

4.1 Water management

Regardless of whether you have a liquid feeding system or a dry feed system, water should always be freely accessible 24h a day. Water nipples should be placed in a height appropriate for the age and size of the pigs, preferably use the shoulder of the smallest pig to determine the height. Drinkers should also be placed with enough space between them, so that more pigs can drink simultaneously. If one pig can block the access to another drinker while using a different drinker itself, the drinkers are placed too close together. To avoid competition, always ensure that the number of water access points coheres with the number of pigs in the pen. A study by Van der Peet-Schwering et al., (2014) advised 1 drinking nipple per 10 rearing gilts. Other local guidelines advise 5-7 pigs per drinker (Norwegian Food Authority, 2021). Always check what the national legislations are for your country.

4.2 Water requirements

Water requirements are different per life stage of the pig. In Table 1 the recommended water requirements and water flow can be seen. Current research provides only estimated water requirements because there are many different factors that can influence the daily amount of water required by rearing gilts (Andersen et al., 2014). To make sure water intake per day is sufficient, a general rule that can be used is that rearing gilts will consume 2.5 to 4.0 times more water than feed per day. New data on water consumption from a commercial farm in Norway shows that sows increase their water consumption as parturition approaches, and consume on average 32 L/d and 37 L/d for gilts and sows respectively (Thingnes et. al., 2021). In the lactation period the water consumption was on average 43 L/d for sows and 38 L/d for gilts. As a rule of thumb, a sow needs 4 liters of water to produce one liter milk.

Table 1. Water requirements in pigs.

Animal category	Water requirements (L/day)	Water flow (L/min)
Piglets (lactating and weaners)	1-5	>0.5
Grower and finishers	6-10	>1.0
Rearing gilts	7-12	>1.0
Gestation gilts and sows	20-40*	>1.5
Lactating gilts and sows	25-50*	>4.0#

* Water intake can reach 40 L at the end of gestation. Based on Norwegian recommendations and research (Thingnes et al., 2021).
# The high flow rate can be reached with a big drinker which allows a high volume at a low pressure.

4.3 Water requirements

Water volume and pressure will influence the water consumption of pigs because pigs usually drink right after they eat, and they will not stand around drinking for a long period of time. So, if the water pressure is too low, they will most likely consume less than they require. Water delivered at high pressure is as bad as low pressure due to intake difficulty. On the other hand, water volume has also influence on water consumption of pigs. Therefore make sure that the right drinker with the right yield is used per age category (nursery, rearing, gestation, lactation).

4.4 Water quality

The provided water should be of good quality: clean, clear, and fresh. The bacteriological and chemical guidelines for drinking water quality need to be checked locally on the quality standards.

5. CALCIUM AND PHOSPHORUS

Optimal bone development is the key to ensure longevity of the TN70 sow. Therefore, proper nutrition during all stages is highly important. The right levels of calcium (Ca) and phosphorus (P), and even more important, the ratio between these minerals are crucial in all diets.

Ca and P are the most essential minerals for proper bone and skeleton development and for claw quality. In detail, 99% of Ca is present in the skeleton and only 1% of this Ca is transferred into Ca that circulates in the body and in soft tissues (Schaafsma, 1981). It is also known from Van Riet et al. (2013) that Ca has an impact on horn production and consequently claw quality: insufficient dietary Ca levels might lead to weaker claws.

P is essential for bone development and plays a key role in metabolic processes such as the formation of cellular membranes and it is vital for enzymatic systems involved in protein and carbohydrate metabolism. To optimize growth performance and minimize nutrient excretion, the inclusion of dietary Ca and P needs to be adequate. There are different ways to express Ca and P levels. An example is given for P:

- **Total P:** all P that is present in an ingredient, including non-available P (which is mostly bound to phytic acid).
- **Available P:** shows relative bioavailability, this may overestimate real amount of P that is utilized (available P = total P – P bound in phytic acid).
- **Digestible P:**
  - **Apparent total tract digestibility (ATTD) P:** this includes basal endogenous P losses
  - **Standardized total tract digestibility (STTD) P:** is corrected for basal endogenous P losses. Endogenous substances are for example bile, mucus, digestive enzymes, and epithelial cells.

The metabolism of Ca is linked to that of P which means that they are antagonists of each other. An oversupply of dietary Ca can negatively affect the digestibility of P. Furthermore, an oversupply of dietary Ca reduces feed intake and average daily gain. The negative effect of excess of Ca on growth performance is mitigated by increasing dietary P above the requirement.

5.1 Maximizing bone ash versus maximizing growth performance

It is important to define the goal of the rearing period of TN70 gilts until first insemination. It is important in breeding gilts and sows to focus on longevity and to ensure proper bone development. The ratio between STTD-Ca and STTD-P appears to be more important than the dietary Ca and P levels (Lee, Lagos & Stein, 2019). A higher level and ratio of Ca and P improves ash content in bones, thus bone ash is an indicator for bone strength and development. Bone ash is the residue left after heating of bones at high temperatures. From literature it is known that if maximizing bone ash is the goal instead of maximizing growth performance, then the ratio STTD-Ca:STTD-P needs to be larger (Lee, Lagos & Stein, 2019). In the table below (Table 2), the differences between bone ash maximization or growth performance maximization of different growth phases are given.

Table 2. Requirements for Ca to maximize growth performance or bone ash expressed as a ratio between STTD-Ca and STTD-P for growing and finishing pigs fed diets that met the STTD-P requirement[1] (adapted from Lee, Lagos & Stein (2019)).

Objective	Body weight range			
	11 to 25	25 to 50	50 to 85	100 to 130
Growth performance	<1.40:1	<1.35:1	<1.25:1	<1.10:1
Bone ash	1.70:1	1.80:1	2.00:1	2.30:1

[1] STTD-P requirement estimation are based on NRC (2012).

Global Nutrition and Female Reproduction Services team did research in the work of Bikker & Blok (2017) related to the ratios between Ca and P to define a uniform global advice on how to implement this item in gilt development diets and in sow diets to ensure longevity.

Bikker & Blok (2017) reported Ca:STTD-P and STTD-Ca:STTD-P ratios for different animal categories which lead to a Ca:STTD-P ratio of 2.7-2.8 for growing pigs, 3.2 for gestating sows and 3.0 for lactating sows (Table 3).

Table 3. Ca:STTD-P and STTD-Ca:STTD-P ratios for different animal categories, adapted from Bikker & Blok. (2017).

Animal category	Ca:STTD-P	STTD-Ca:STTD-P
Growing pigs, 25-45 kg (55-99 lbs)	2.7	1.6
Growing pigs, 45-70 kg (99-154 lbs)	2.7	1.6
Growing pigs, 70-120 kg (154-265 lbs)	2.8	1.7
Sows in complete gestation	3.2	1.6
Sows in lactation	3.0	1.5

5.2 The use of phytase in pig diets

Phytase is a digestive enzyme that breaks down the phytate and releases phosphorus in an useable form to the animal. Phytase can be used to reduce environmental impact by limiting phosphorous excretion in several countries and it can also be used to improve feed efficiency. As phytase releases more phosphorus in the diet, it influences the Ca:STTD-P ratio and the mineral content. The contribution of phytase to the total mineral content of the diet should be carefully evaluated as it might lead to an overestimation or underestimation. As such, we should be careful of the influence of phytase on the levels of Ca, STTD-P and ratio between those as undesired problems can appear.

5.3 Vitamin D importance

Vitamin D is important when it comes to leg quality as it stimulates the absorption of Ca and P from the intestine. Most of the time the diets are supplemented with vitamin D in form of cholecalciferol (vitamin D3) which is then converted by the liver into 25(OH)D3 and subsequently converted by the kidneys into 1.25(OH)2D3.

Leg quality can be improved by adding the maximum amount of vitamin D allowed by legislation and by replacing partially (50%) or up to 100% of vitamin D3 by commercial forms of (25(OH)D3).

5.4 Particle size of calcium

A decrease in particle size of feed ingredients is associated with higher nutrient digestibility. Calcium carbonate (CaCO3) can be included in pig diets at a diverse range of particle sizes without affecting Ca or P digestibility, retention, and growth performance of weaned pigs. It is advised to use particle sizes of CaCO3 ranging from 0.2 – 1.1 mm in pig diets (Merriman & Stein, 2016).

5.5 Advice Global Nutrition and Female Reproduction Services

Global Nutrition and Female Reproduction Services is utilizing total Ca and STTD-P (usually referred as digestible P) levels when guidance is offered to our clients. We provide and support usage of total Ca and not STTD-Ca since there is a lack of digestibility data on Ca in feed ingredients (NRC, 2012). Our objective is to focus on longevity, bone mineralisation and sustainable production in the entire productive life of the TN70 sow. To achieve this, we focus on the ratio Ca to STTD-P with a minimum level of STTD-P to support development while minimizing impact on the environment. The ratios given in Table 3 are used as global advice and to establish our recommendations for rearing gilts and sows.

6. THE IMPORTANCE OF DIETARY FIBRES

Food and feed consist of different fractions: protein, fat, carbohydrates, ash and moisture. Dietary fibres, together with sugars and starch, belong to the carbohydrates fraction. Generally speaking, dietary fibres are the substances that are not digested in the small intestine and end up undigested in the large intestine.

6.1 Fermentable fibres

Fibres are partially digested in the small intestine, but bacteria present in the large intestine are able to digest certain fibres, through fermentation. The beneficial microorganisms in the gut react on the supply of fibres by increasing the amount of microorganisms and fermentation activity. Through this process, specific energy sources are released gradually, for example butyric acid. These sources contribute to energy metabolism and gut health. The gradual release provides a long-term energy supply which will result in healthier and calmer sows. Most common raw materials known for their fermentable fibre are beet pulp, citrus pulp among others.

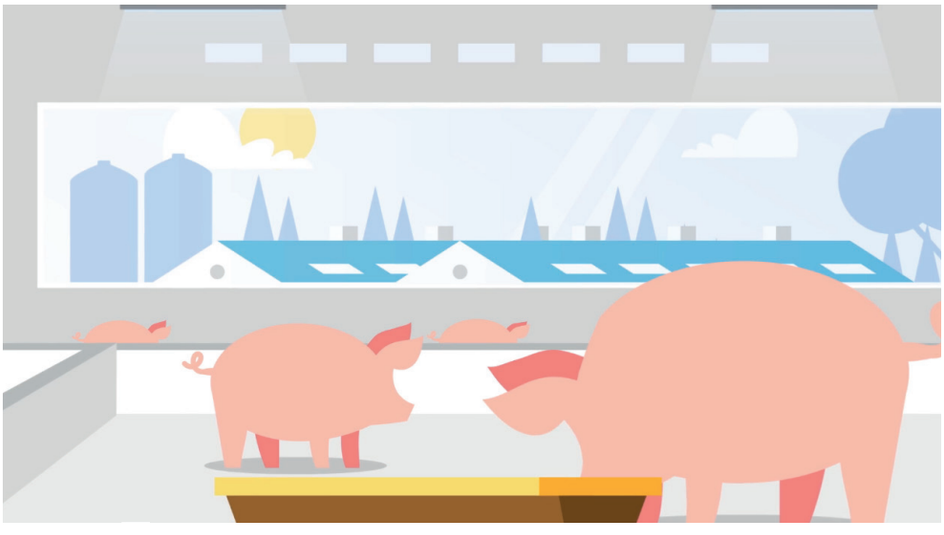
6.2 Fermentable fibres

Not all fibres are broken down by bacteria present in the large intestine. The non-digestible fibres pass the intestines and eventually they are excreted by the body. These fibres are so-called inert fibres or inert carbohydrates. This does not mean that these fibres are unnecessary or not useful. They stimulate bowel movements and improve satiety which helps to prevent greedy eating behaviour and therefore ensure a more regular feed intake. In addition, pathogenic bacteria are less likely to attach to the intestinal wall. Thus, non-digestible fibres do have an important function. Most common raw materials known for their non-digestible fibre are wheat bran, sunflower hulls, rice hulls, oat hulls, palm kernel among others.

6.3 Fine or coarse grinding of fibre rich raw materials

Finely ground raw materials ensure better nutrient absorption and improve animal performance. However, grinding fibres will lower their positive effect on the gastrointestinal tract which will not able to perform optimally. Sow feed is used to keep the animals healthy and meet their nutritional requirements. Therefore it is important to grind finely the protein and a large part of starch fraction and let the fibre rich raw materials more coarse. This will help the gastrointestinal function and enable the most efficient utilization.

However, it is important to realize that fibres have low nutritional value and there are big differences between fibres and their working mechanism. Too low fibre level in the diet will impair animal health and performance, while too much fibre inclusion is also not desired and will have a negative effect on animal performance as well.



7. GILT REARING

7.1 Introduction

Proper gilt development and management has a significant impact on sow lifetime performance. Proper gilt management includes everything from transportation, adaption, quarantine, housing, and vaccination programs to nutrition, development, selection, socialization, and insemination. If any of these areas are compromised, it can affect lifetime productivity overall.

The aim of this chapter is to provide the necessary information on how to rear, manage, and feed the future reproductive sow to ensure a high lifetime production performance.

An ideal replacement gilt:

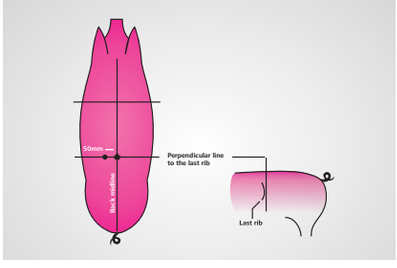
- Is easy to feed and manage
- Has at least 16 functional teats
- Has a strong structural development
- Is socialised

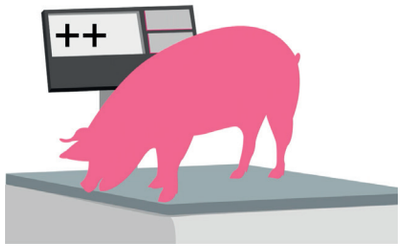
7.2 Insemination targets

The target of the feed program is to develop the gilts in such a way that they will have the proper weight and confirmation at insemination. TN70 gilts develop and grow faster, are leaner and have an average to good appetite compared to other similar breeds available in the market. The growth rates that are mentioned in this manual are from birth up to the moment of first insemination and are expressed in grams per day. Targets that are given below are based on Topigs Norsvin data, and the paper Modern Gilt Rearing (Opschoor, Knol & Zak, (2019)) and validated with literature.

The recommended insemination targets are given below:

- **Insemination weights:** 150 - 170 kg
- **Backfat:** 11 - 13 mm
- **Age:** 210 - 240 days
- **Number of heats:** Second or third heat
- **Growth rate (birth-first insemination):** >650 g per day while preventing overdevelopment





It is highly recommended to monitor and measure all replacement gilts on the given parameters (age, weight and backfat) to ensure that gilts are inseminated within the given target ranges.

Inseminating gilts

The consequences of inseminating gilts when they are outside the given target ranges:
Underdeveloped gilts (<150 kg, <11 mm, >210 days and <650 g/day)

- Will lead to less mature and underdeveloped gilts in the farrowing pen.
- Lowers overall lifetime reproductive performance.
- Lowers feed intake capacity.
- Will have insufficient body reserves to support bigger litters.
- Will lead to higher body condition losses during first lactation, which could lead to second parity dips or premature culling.

Overdeveloped gilts (>170 kg, >13 mm and <240 days and >800 g/day)

- Increases the sow's maintenance requirements.
- Decreases sow herd feed efficiency.
- Increases the risk for lameness, thus possibly reducing longevity.
- Increases the overall physical size of the sows in the herd.
- Have more farrowing difficulties that may increase the number of stillborn piglets.
- Will be more prone to feed refusal during lactation.

7.3 Weight development

The main objective during rearing is to ensure a controlled and steady growth and development of the gilts. The weight development of the TN70 replacement gilt needs to be monitored on a regular basis, and if necessary, diets and/or feeding strategies must be adjusted to ensure that gilts are developing within the given weight development ranges.

Irregular growth of gilts may cause osteochondrosis (OC) which is a lameness-related condition that can result in premature culling of breeding sows (Van Grevenhof et al., 2012). OC usually affects individuals at early growth stages. The recommended weight curves and feeding strategies of the TN70 replacement gilt take this timeframe into account by avoiding too rapid growth in the youth phase (25 to 55 kg) but allowing the gilts to develop more natural, but still controlled in the later phases of the development trajectory. This growth strategy ensures a more optimal structural development during rearing and it can also prevent the occurrence of OC.

Ensuring a sound structural development in gilts during rearing can be achieved by controlled feeding, but it is preferable to control the growth development through dietary energy restriction and phase feeding.

Growth curves

Different raw materials are used around the world to feed gilts. The feeding strategies and diets fed to gilts also vary from farm to farm and country to country. These differences will have an impact on the growth rate and weight development of the rearing gilt. The recommendations for gilt weight development by Topigs Norsvin take these differences into account by dividing gilts into two growth groups: A “slower growing” and a “faster growing” group. Growth rates are expressed in grams per day from birth to first insemination.

Table 4. Recommended weight development during rearing for the TN70 gilt.

Weeks	Day	Slow growers (kg)	Topigs Norsvin Advice (kg)	Fast growers (kg)
9	63	26	**27**	28
10	70	31	**32**	32
11	77	35	**36**	38
12	84	40	**42**	43
13	91	46	**47**	49
14	98	52	**53**	55
15	105	57	**59**	61
16	112	64	**66**	67
17	119	70	**72**	74
18	126	76	**78**	81
19	133	82	**85**	87
20	140	88	**91**	94
21	147	95	**98**	101
22	154	101	**104**	107
23	161	107	**110**	113
24	168	113	**116**	119
25	175	118	**122**	125
26	182	124	**127**	131
27	189	129	**133**	137
28	196	134	**138**	142
29	203	139	**143**	147
30	210	143	**148**	152
31	217	148	**152**	157
32	224	152	**156**	161
33	231	156	**160**	165
34	238	159	**164**	169
35	245	163	**168**	173
36	252	166	**171**	176

The aim is to ensure that gilts develop between the lower and upper boundary. Measuring (weighing) of gilts on a regular basis will ensure that they develop as recommended. Feed programs must then be adjusted accordingly. Regardless of the gilts growth rate during rearing, the insemination targets set for the TN70 need to be reached before insemination.

Conformation traits

Conformation traits are determined traits to indicate the general body shape of the pig in terms of its framework of skeleton and muscle structure. These conformation traits, defined by Topigs Norsvin (Topigs Norsvin, 2017), are:

- Good flex to pasterns
- Adequate stance base, both front and rear legs
- Good claw quality
- Composition
  - Long bodied
  - Evenly spaced and well-developed underline with a minimum of 16 developed teats
  - Top line that has no steep or dipped curve
  - Sufficient muscling degree
  - Well-developed vulva that is not small, tipped up or injured
- Locomotion: "cat-like" movement, no swinging action from the hips as the pig moves.

7.4 Feeding strategies

Preventing gilts from becoming underdeveloped or overdeveloped before mating through feeding management is a challenge for many producers (Faccin et al., 2017).

There are two feeding methods to rear gilts:

Ad libitum feeding

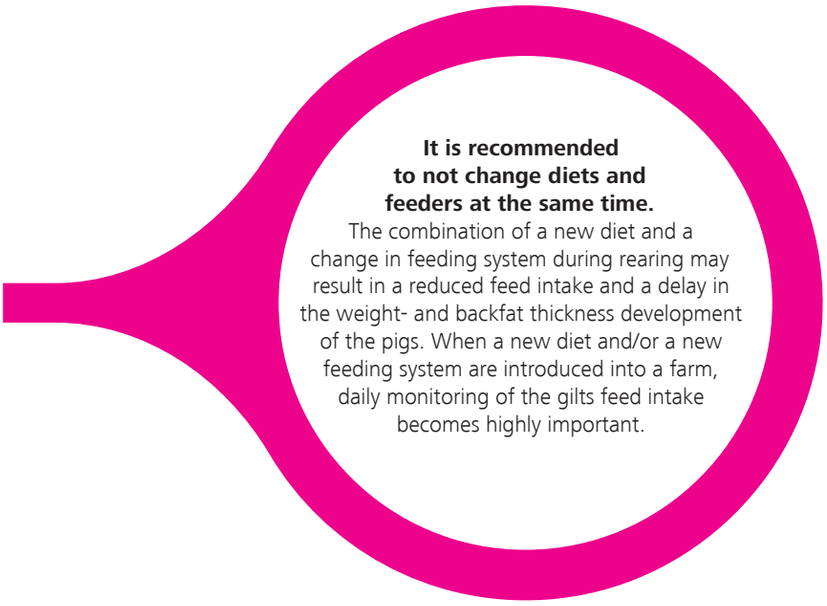
The TN70 gilt is less likely to develop an excessive body condition compared to moderate- or low-lean maternal gilts that have a higher potential for fat deposition and becoming overly conditioned. Therefore, the TN70 gilt can be fed ad libitum during the rearing period, if the following conditions are met:

- It is preferred to use three specially developed gilt rearing diets (three-phase feeding).
- Additional minerals and vitamins to support lean growth and bone development.
- Continuous monitoring of weight development to ensure that insemination targets are reached.

Restricted or controlled feeding

It is known that controlled feeding of gilts is an effective method to prevent excessive body condition (Thingnes et al., 2012). Topigs Norsvin recommends that gilts are allowed to develop controlled but normally during rearing. This can be achieved by either lowering the nutrient levels in the first phase diets, or by controlled feeding. Dietary restriction through lowering the energy levels is the preferred method for controlling their growth, because it is important to keep the young gilts full and satisfied. Keeping the gilts full and satisfied is also a preventative measure to avoid stereotypic behaviour, fighting and tail biting.

Proper feeding management during rearing that ensures a good body condition and soundness of legs and feet, is important for a gilts overall reproductive performance. The nutrient recommendations and feeding strategies for gilt rearing in this manual are limited to the period from 25 kg to 170 kg live weight. The Topigs Norsvin nutrient recommendations for gilt development are designed to meet nutrient demands for adequate protein growth and to maximize the productive life of the gilt.



They are not designed to maximize average daily gain (ADG), as would be the goal of a commercial feeding program.

Topigs Norsvin recommends feeding a three-phase dietary program to gilts, starting from 25 kg until first service. A three-phase feeding program offers the flexibility to better feed to the needs of the gilts, but also to control and steer their development better. A three-phase dietary program offers the possibility to feed the gilts more restrictively on nutrients during the earlier stages of rearing, and then diets with more functional fibre can be used in later phases ensuring the satiety of the animals while allowing them to develop normally.

Most commercial pig diets are either corn-soybean based, or wheat-barley-soybean based. Pigs fed a well-balanced wheat-barley-soybean based diets can perform as well as those fed corn-soybean diets, the main difference being the minimal energy levels reachable when using these two different groups of raw materials. The dietary recommendations for gilt rearing in this manual take these differences into account, by providing a minimum and maximum level for each nutrient. In Table 6 the minimum nutrient levels represent the wheat-barley-soybean markets and the maximum nutrient levels represent the corn-soybean markets. The ratio between SID Lysine and Energy are similar for both feed markets.

Recommended program for rearing of the TN70 gilt:

- The rearing program should start at 25 kg and end at first service.
- Use a minimum of three dietary phases during the rearing period.
- Ensure that there is a smooth transition between the diets.
- Start flushing gilts at least 10 to 14 days before first service.
- The feed program (dietary recommendations) is related to the given weight and feed intake targets.

7.5 Daily nutritional requirements

Table 5. Daily nutritional requirements and weight development curve of TN70 gilts.

Weeks	Day	Weight (kg)	Feed intake (kg)	NE (MJ/day)	SID Lysine (g/day)
9	63	27	1.1	11.9	12.8
10	70	32	1.3	13.3	14.2
11	77	36	1.5	14.7	15.5
12	84	42	1.6	16.0	16.7
13	91	47	1.8	17.3	17.8
14	98	53	2,0	18.6	18.7
15	105	59	2.1	19.8	19.5
16	112	66	2.2	20.9	20.0
17	119	72	2.3	21.9	20.5
18	126	78	2.4	22.8	20.7
19	133	85	2.5	23.6	20.9
20	140	91	2.6	24.4	20.8
21	147	98	2.6	25.1	20.7
22	154	104	2.7	25.7	20.5
23	161	110	2.7	26.3	20.1
24	168	116	2.7	26.8	19.7
25	175	122	2.8	27.2	19.2
26	182	127	2.8	27.6	18.7
27	189	133	2.8	28.0	18.1
28	196	138	2.8	28.3	17.5
29	203	143	2.8	28.5	16.9
30	210	148	2.8	28.8	16.3
31	217	152	2.9	29.0	15.7
32	224	156	2.9	29.2	15.1
33	231	160	2.9	29.3	14.5
34	238	164	2.9	29.5	13.9
35	245	168	2.9	29.6	13.4
36	252	171	2.9	29.7	12.8

The daily requirements for net energy (NE) and standardized ileal digestible (SID) lysine are determined based on the body weight of the animal. Therefore, the weight curve presented above is the leading factor for the determination of these requirements.

7.6 Nutrient recommendations

Table 6. Dietary recommendations for a three phase rearing program.

Weight range	Nutrients	Unit	Min*	Max*
Rearing 1 (25-55 kg)	Net Energy	MJ/kg	9.9	10.2
	SID Lysine	g/kg	10.3	10.6
	SID Lys/NE	g/MJ	1.04	1.04
	Calcium	g/kg	8.1	8.6
	Available Phosphorus[1]	g/kg	3.9	4.1
	Digestible Phosphorus[1]	g/kg	3.0	3.2
	Ca:Digestible Phosphorus[1]	-	2.7	2.7
Rearing 2 (55-100 kg)	Net Energy	MJ/kg	9.7	10.0
	SID Lysine	g/kg	8.4	8.7
	SID Lys/NE	g/MJ	0.87	0.87
	Calcium	g/kg	7.6	8.1
	Available Phosphorus[1]	g/kg	3.6	3.8
	Digestible Phosphorus[1]	g/kg	2.7	2.9
	Ca:Digestible Phosphorus[1]	-	2.8	2.8
Rearing 3 (100 kg-Ins.)	Net Energy	MJ/kg	9.5	9.9
	SID Lysine	g/kg	6.4	6.7
	SID Lys/NE	g/MJ	0.68	0.68
	Calcium	g/kg	7.0	7.6
	Available Phosphorus[1]	g/kg	3.4	3.6
	Digestible Phosphorus[1]	g/kg	2.5	2.7
	Ca:Digestible Phosphorus[1]	-	2.8	2.8

[1] The level of digestible phosphorous (g/kg) is expressed as STTD P (standard total tract digestibility) and is calculated by dividing daily requirements by daily feed intake of the animals. We recommend utilization of phytase to reduce phosphorous excretions and environmental impact.

***MIN =** WHEAT-BARLEY-SOYBEAN MARKET

***MAX =** CORN-SOYBEAN MARKET

7.7 Amino acid, vitamin and mineral requirements for gilts

Amino acid requirements
The amino acid levels are normally expressed in relation to the level of Lysine in the diet since this is the first limiting amino acid. The calculated digestibility coefficients will differ between feed ingredients; therefore, when formulating more complex diets, we recommend that standardized ileal digestible values are used. The amino acid levels displayed in Table 7 are given as SID (standardized ileal digestible). The ratios between the amino acids can be different for several reasons. Therefore, the given boundaries by Global Nutrition and Female Reproduction Services are developed from various sources to give the possibility to design the optimal diet that will fit on the local circumstances.

Table 7. Amino acid requirements for the TN70 gilt*.

Amino acids	Rearing 1 (25-55 kg)		Rearing 2 (55-100 kg)		Rearing 3 (100 kg-Ins.)	
	Min	Max	Min	Max	Min	Max
SID Lysine	100	100	100	100	100	100
SID Methionine	32	34	32	34	34	36
SID M+C	58	61	59	62	62	65
SID Threonine	65	67	66	68	69	71
SID Tryptophan	20	22	19	21	19	21
SID Valine	67	69	67	70	67	75
SID Isoleucine	56	60	56	60	60	67
SID Leucine	100	108	100	108	101	108
SID Histidine	34	36	34	36	34	36
SID Phenylalanine	55	60	55	60	58	62

* The recommended amino acid profile was compiled based on various resources like CVB (2020), FEDNA (2013), NRC (2012) and practical experience of our nutrition team.

Vitamin and mineral requirements
The vitamin and mineral requirements are given in Table 8 and 9.
Global Nutrition and Female Reproduction Services has developed Tables 8 and 9 from various sources. The goal with these boundaries is to achieve high quality gilts and not the lowest feed costs.

Table 8. Vitamin requirements for TN70 gilts*.

Vitamins		Rearing 1 (25-55 kg)		Rearing 2 (55-100 kg)		Rearing 3 (100 kg-Ins.)	
	Units	Min	Max	Min	Max	Min	Max
Fat soluble vitamins							
Vitamin A (Retinol)	IU	10000	12000	10000	12000	10000	12000
Vitamin D3 (Cholecalciferol)#	IU	1800	2000	1800	2000	1800	2000
Vitamin E	mg	80	150	80	150	80	150
Vitamin K3 (Menadione)	mg	2.0	4.5	2.0	4.5	4.5	6.0
Water soluble vitamins							
B1 (Thiamine)	mg	2	3	2	3	2	3
B2 (Riboflavin)	mg	6	10	6	10	6	10
B3 (Niacin)	mg	25	50	25	50	35	70
B5 (Pantothenic acid)	mg	20	30	20	30	25	40
B6 (Pyridoxine)	mg	3.5	6.0	3.5	6.0	3.5	6.0
B7 (Biotin)	mcg	300	500	300	500	300	800
B9 (Folic acid)	mg	3.0	5.5	3.0	5.5	4.0	6.0
B12 (Cyancobalamin)	mcg	30	50	30	50	30	50
C (Ascorbic acid)	mg	+	300	+	300	+	300
Choline (Betaine)	mg	250	500	250	500	500	800
L-carnitine	mg						50

* The vitamin requirements were compiled based on various resources like BASF, DSM (2016), FEDNA (2013), LFL (2019), NSNG (2010), NRW (2016) and practical experience of our nutrition team.
# The level of these vitamins should be adjusted according to local legislation and own objectives.

Remarks:
- Use of minimal 50% vitamin D in the form of 25(OH)D3 as recommended by Global Nutrition and Female Reproduction Services.
- Vitamin inclusion levels are focused to support maximization of bone mineralization and optimal performance and not necessarily the lowest feed costs.
- The recommended vitamin standards are the amounts added without considering the contribution of raw materials.

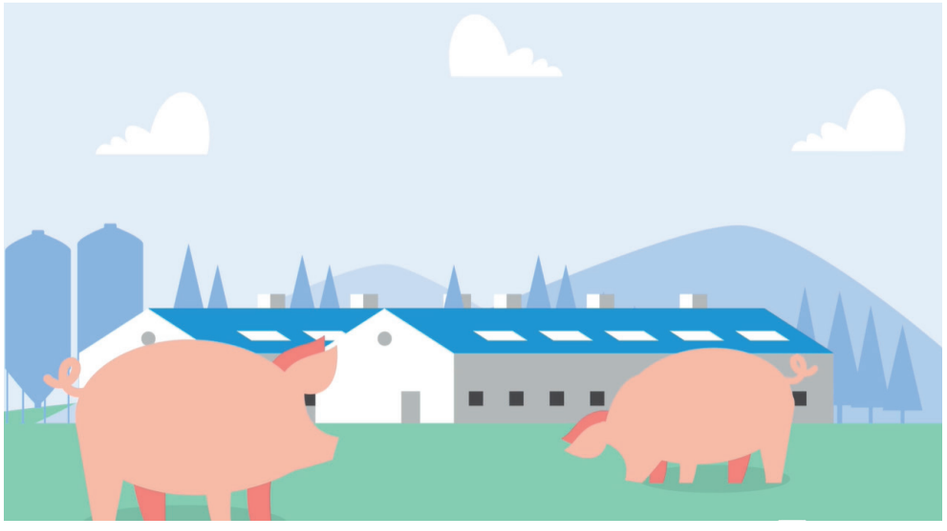
Table 9. Mineral requirements for TN70 gilts*.

Trace elements		Rearing 1 (25-55 kg)		Rearing 2 (55-100 kg)		Rearing 3 (100 kg-Ins.)	
	Units	Min	Max	Min	Max	Min	Max
Na	%	0.20	0.25	0.20	0.25	0.20	0.25
K	%		1.10		1.10		1.10
Mg	%	0.25	0.40	0.25	0.40	0.25	0.40
Fe	mg	120	180	100	180	100	200
I	mg	1	2	1	2	1	2
Se	mg	0.3	0.5	0.3	0.5	0.3	0.5
Cu	mg	15	25	15	25	15	25
Zn	mg	120	150	110	150	110	150
Mn	mg	50	100	50	100	50	100
Cl	%	0.15		0.15		0.15	
dEB (Na + K - Cl)	meq/kg	180	240	180	240	180	240

* The minerals requirements were compiled based on various resources like FEDNA (2013), LFL (2019), NSNG (2010), NRW (2016) and practical experience of our nutrition team.
# The level of these minerals should be adjusted according to local legislation and own objectives.

Remarks:

- Mineral inclusion levels are focused to support maximization of bone mineralization.
- The recommended mineral levels are presented as total amount in the feed.
- We recommend to use organic or chelated minerals as recommended by the suppliers.
- The target dEB (Na+K-Cl) for gilt diets is to ensure maximum bone mineralization.



7.8 Management in the rearing facility

Farm lay-out
Multi-site systems are an ideal way to separate gilts, sows and finishers which is desirable in terms of management, nutrition and health. A special "gilt development unit" (GDU) is a perfect example to raise and manage gilts separately and away from teaser boars and sows. However, this is not always possible in the existing farm lay-out. When gilts are raised internally; management, nutrition and health still need to be organized differently to ensure well-developed gilts in the rearing facility. In this chapter, more management items in the rearing facility are discussed.

Socialisation
Pigs are social animals, and the TN70 sow is no exception. Socializing gilts before insemination is a good investment because socialised animals are easier to handle, show a stronger standing response, and take better care of their litter after parturition.

Aggression in sows is mainly due to fear and poor socialisation with humans, and in group housing systems it is important to avoid fearful animals, because animals that feel threatened and have nowhere to escape will defend themselves. Spending a few minutes every day in the gilt pens should be part of the daily routine. Exploit their curiosity and let them come and seek contact. After some time, the handler should be able to touch, pet and scratch them. The key is to stay calm and let the gilts initiate the contact. Proper socialisation during rearing will have a positive impact throughout the animal's adult life.

Improving bone, leg, and claw quality
It has been the common practice in many countries to rear replacement gilts using finisher or gestation diets. Maximizing lean growth by using a finisher diet could lead to osteochondrosis and leg weakness and possibly result in an increase in the herds replacement rate. This is partly due to the vitamin and trace element levels in finisher diets which do not support optimal bone development and reproductive performance. The current changes to sow group housing systems will require animals with a sound leg and claw development. Topigs Norsvin gives the following recommendations with regards to improving bone, leg, and claw quality during rearing:

- Prevent excessive growth rates: Follow the given recommendations for an average growth rate of 650-780 g/d from birth to insemination. Monitor the weight development of the gilts closely by using the given weight development graphs. Make the necessary adjustments to the diets and feed programs to ensure that the gilt develops within the ideal weight boundaries.

- Use more available mineral sources: Fabà et al. (2018) has shown that the inclusion of highly available trace elements improves gilt performance and results in better conformation and skeletal development. Consider the differences in the availability of essential minerals between different mineral sources.

- Optimize the dietary electrolyte balance (dEB, Na+K-Cl): If a sow's diet has an overload of anions (-) compared to cations (+) the risk of acidosis increases. If the incidence of acidosis is prolonged, less bone formation and even bone degradation can take place because of calcium mobilization.

- Correct calcium and phosphorus levels (ratio): The Ca and STTD-P requirements for bone ash maximalization are higher than the requirements for optimal growth rate and feed efficiency (Lee, Lagos & Stein, 2019). Follow the given recommendations and ensure that any readjustments are done correctly when using phytase to avoid overestimation of STTD-P which will have a negative influence on maximizing bone ash.

- Minerals and vitamins: The mineral and vitamin need of the reproducing female are greater than that of finishers. For gilts entering the breeding herd, the typical vitamin premix in the finishing diet should be replaced with a" breeder" vitamin premix. This premix should contain increased levels of the fat-soluble vitamins A, D, E and K and the water-soluble vitamins B with special attention to choline, biotin and folic acid that are relatively low or absent in typical finishing diets.

- Flooring quality: Good claw health requires good flooring. The floor must be kept dry and non-slippery to provide a good grip and to reduce the risk of injuries. Also, attention should be paid to gap width of the flooring to prevent claw injuries

Boar exposure during rearing
The goal of early boar exposure in the gilt development unit (GDU) is to detect early puberty in gilts so we can breed them at an earlier age (with sufficient body weight). The benefits of early puberty identification in gilt management are (Topigs Norsvin, 2021) :

- Fewer non-productive days
- Gilts with stronger estrus signs are more likely to farrow
- Gilts with delayed puberty show delayed estrus after weaning their first litter

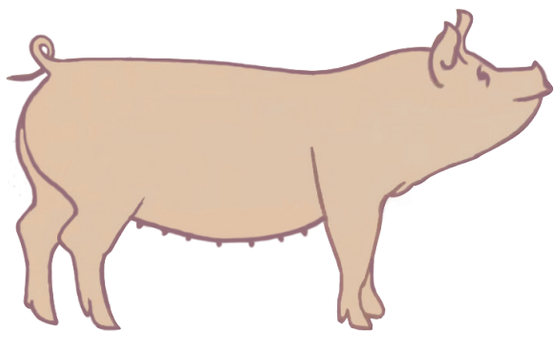
To achieve optimal early boar exposure, the following procedures are advised (Patterson et al., 2002, paper Gilt rearing strategies for sow longevity (Opschoor, Knol & Zak, (2019)):

Start early boar exposure	● 23 weeks
Direct boar contact	● Put boar in pen with gilts or on BEAR* area ● Back pressure test gilts ● Record gilt behaviour and vulval changes ● Prevent boar from mounting gilts
Frequency	● Ideally twice daily, in the morning and in the afternoon, 7 days a week
Boar	● >10 months old ● Active ● High libido ● Smelly ● Good salivation
Ratio boar:gilts	● 1 boar per 20-30 gilts
Duration of exposure	● 10-15 minutes per pen

* BEAR: boar exposure area

Light management during rearing
It is advised to apply a constant day-night rhythm in all seasons of 16 hours light and 8 hours dark with a minimum light intensity of 40 lux for rearing gilts (Van der Peet-Schwering et al., 2014; RVO, 2021; NWVA, 2021), but always check local regulations. When early boar exposure is started at the age of 23 weeks ± 2 weeks, the light intensity can be increased to a minimum of 100 lux if possible, because the goal is to induce estrus in this phase.

Pen design during rearing
A good housing and pen design is important to rear prolific gilts for the future sow herd. Sufficient space is needed for skeletal and muscle development and stimulation of each other as they come into estrus. Also, insufficient floor space could result in occurrence of antagonistic behaviour among gilts. The required space depends on the type of feeding system, group size and pen layout. The largest/oldest gilts should be used as the standard when calculating space requirements.



The following space requirements are suggested to achieve an optimal environment for rearing gilts from 25 kg (Table 10):

Table 10. Overview of space requirements for an optimal environment for rearing gilts.

Number of gilts per pen	● 6-10 gilts per pen, preferably grouped by age
Floor spacing (including feeder)	● 25-100 kg live weight = 1.1 m^2 ● 100-120 kg live weight = 1.3 m^2 ● 100-140 kg live weight = 1.5 m^2
Floor design	● Preferably solid concrete flooring
Number of animal per feeder space	● Maximum 10 animals per 1 feeder space in dry feed
Enrichment	● See chapter "Management in gestation unit"

Table 11. Minimum feeder space recommendations.

Weight of pig (kg)	Trough/Hopper Length per pig	
	Restrict feed (mm)	Ad lib fed (mm)
5	100	75
10	130	33
15	150	38
35	200	50
60	240	60
90	280	70
120	300	75
120+	350+	75+

Source: https://www.thepigsite.com/articles/efficient-feed-usage

Remarks:
- Always check locally applicable laws on space requirements because they can differ from the advised guidelines mentioned above.
- The advice is based on practical experiences from multipliers in the Netherlands and Norway to ensure proper development of legs.
- Concrete flooring will have a beneficial effect on claw and leg quality (Vermeij, 2004).

Climate guidelines during rearing
TN70 gilts are known as lean and fast-growing animals with a high feed efficiency. Due to selection on these targets, gain and feed conversion improved rapidly over time. Fast growing animals produce more internal heat and therefore we need to control the environment in terms of room temperature and the ventilation to keep the gilts in their thermo-neutral zone or named as comfort zone.

Global Nutrition and Female Reproduction Services uses guidelines from Klimaatplatform about climate settings in pig stables (Klimaatplatform Varkenshouderij, 2021). In the table below different start temperatures and minimum and maximum ventilation is given per pig category (Table 12).

Table 12. Climate guidelines according to Klimaatplatform Varkenshouderij (2021).

Category	Min. ventilation per pig (m^3/hour)	Max. ventilation per pig (m^3/hour)	Start temperature ventilation (°C)
Growing pigs (23 kg)	6	40	25
Growing pigs (day 5 in GDU)	8	40	22
Growing pigs (day 50 in GDU)	14	80	20
Growing pigs (day 100 in GDU)	17	80	19

Remarks:
- Ventilation guidelines depend on used ventilation system, animal behaviour, health status and feed intake.
- Stable/climate system is designed to avoid draft.
- Ammonia concentration should be lower than 20 ppm measured in resting state of the animal.

7.9 Quarantine and transfer to the sow unit

After the rearing phase gilts need to be transferred/moved into the sow herd. Via a well-designed protocol for quarantine and a planned adaptation of the gilts, they will be ready for insemination. In order to increase the incidence of estrus and improved lifetime performance, gilts need to be adapted and acclimatized to their new environment. To make this process successful, Topigs Norsvin advises to use a separate quarantine and an adaptation facility on farm.

The goal of the quarantine and adaptation unit is to bring a balanced gilt in the sow unit, to protect gilts and the sow herd against clinical diseases and to make sure that gilts have a good quality colostrum with the desired antibodies.

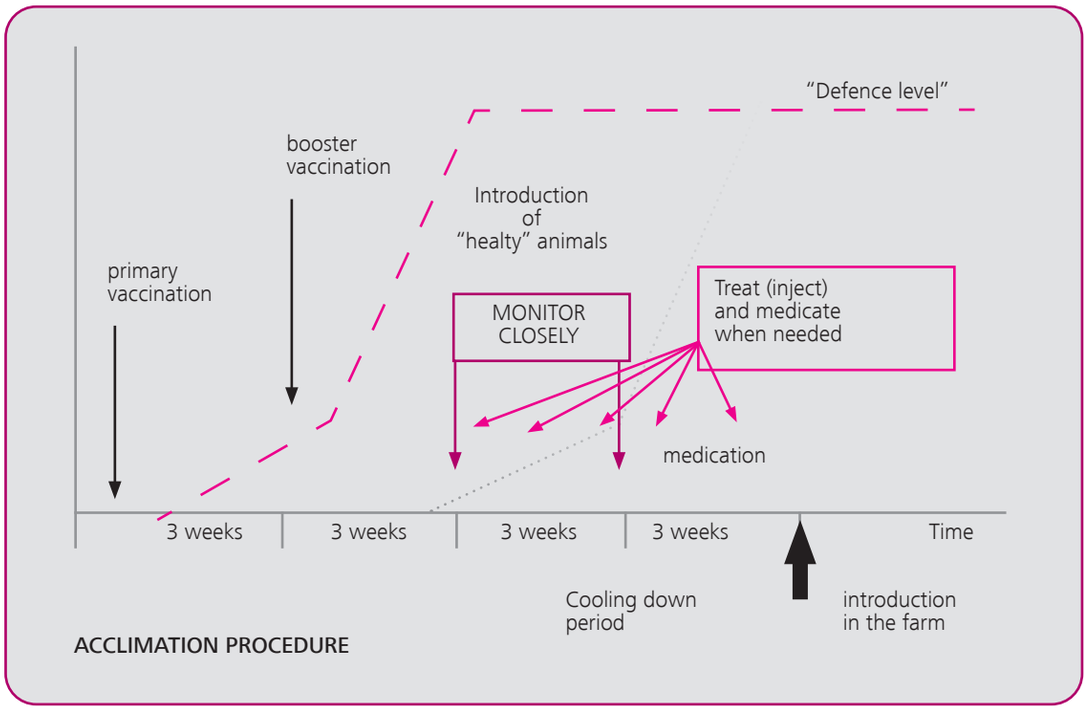
What to do in the Quarantine & Adaptation facility:
Cleaning and disinfection:

- Clean and disinfect the unit before gilts enter the quarantine and adaptation facility. This will make sure that gilts will enter the facility with minimum risk of acquiring infectious diseases before vaccination. Start with gilts with a known health status, otherwise take blood samples.
- Phase 1: Acclimatize to the new environment: gilts will be introduced into a new environment and need to acclimatize before they are ready for vaccination.
- Phase 2: Vaccination: Based on health status of the sow unit, vaccinate the gilts. Be aware of the duration of immunity. Some vaccinations need to be repeated!

Phase 1 and 2 together lasts at least 6 weeks.

- Phase 3: Adaptation: Introduce the gilts to the "germs" present in the sow unit by introducing for example active slaughter sows, ropes or other ways of adaptation.
- Phase 4: Cooling down: depending on the germs present, the cooling down period should be long enough to prevent active spreading at the time of entry into the sow unit.
  Phase 3 and 4 together lasts at least 6 weeks.

Example of Quarantine & Adaptation program



NB: Different situations might require longer cooling down or even shorter. Consult your herd veterinarian for advice on ideal cool down time for your specific herd.

Socializing gilts in the acclimatization phase:
During rearing, gilts are normally housed in smaller groups and are not ready to be kept in different types of housing. In most cases also the feeding systems are different. All these changes will increase the level of stress and discomfort for the gilts. The biggest issue arises when gilts are serviced during this period of increased stress and discomfort. Research has shown that servicing gilts during stressful periods has led to decreased farrowing rates, fewer live born piglets and an increased rate of return and abortions.

Tips during quarantine and acclimatization phase:

- Move gilts preferably to a section where only gilts are housed.
- Check the gilts 2x per day with a minimum of 10-15 minutes per pen with 2 different active boars per day to induce the puberty and improve the quality of the estrus.
- Heat detection should be registered when gilts are still in groups, to ensure that they are inseminated later at the second or the third estrus.
- Use the correct lighting schedule during this phase of 16 hours of (day) light. Make sure space is not limiting, at least 1.0 m2 per gilt to support leg quality.

Transfer to the sow unit
To make the change from the acclimatization unit to the insemination room smooth, it is recommended to adapt the gilts already in the acclimatization phase to the future housing and feed system.

- Make sure there is enough place to house the gilts 2 weeks prior to first insemination.
- Check the level of feed before and after moving the gilts to the sow unit.
- A lower level of feed or a combination of a lower level of feed and a lower nutrient level per kilogram will have a negative effect on weight development and on the energy balance of the gilt.
- Use the correct light schedule in this phase of 16 hours light per day.

8. SOW FEEDING & MANAGEMENT

8.1 Introduction

Nutrition is one of the key components to ensure that the modern sow achieves her genetic potential for (re)production. The nutritional demands of the modern gestating and lactating sow and her litter have changed significantly over time. Today's genetic advancements have resulted in feed efficient, fast growing and leaner pigs. However, this progress has also created new challenges when it comes to feeding the modern sow. Nutrient supply, in the form of amino acids and energy, must be designed to optimize the reproductive performance and to maintain optimal condition (body reserves) for the sows entire productive life. Diets should also be optimized to ensure nutritional welfare and comfort to the animals and also minimize the environmental impact through excretions. To achieve this, a precise adjustment of the feeding level and the feed composition according to the performance level of the sows is required.

8.2 Assumptions for nutrient recommendations

To obtain the maximum productive potential from the TN70 it is fundamental to manage the sow's body condition, to optimize the daily amount of feed offered and to supply the correct dietary requirement levels during all stages of production.

Understanding the different factors that affect nutrient requirements and feed intake can assist in developing a successful sow feeding program.

The feeding advice for the TN70 is based on the following basic assumptions:

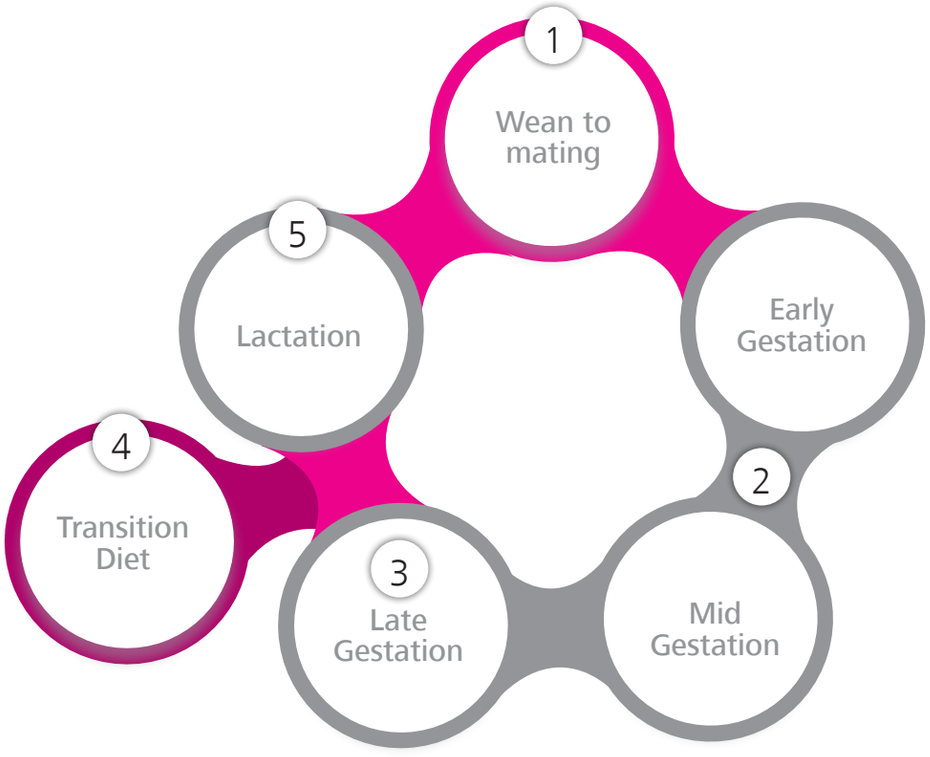
- Controlled feed program.
- Conventional health.
- Optimal housing conditions.
- Thermal neutral conditions.

Most commercial pig diets are either corn-soybean based or wheat-barley-soybean based. Pigs fed well-balanced wheat-barley-soybean based diets can perform as well as those fed corn-soybean diets and the main difference is the minimal energy levels reachable when using these two different feed sources. The dietary recommendations for sows in this manual take these differences into account, by providing a minimum and maximum level for each nutrient. The daily nutrient requirements of a sow in terms of SID Lysine and NE in MJ per day are however similar, independent of any market or available raw materials.

8.3 Feeding strategies

The Topigs Norsvin feeding strategies for the TN70 sow to secure optimal weight development include:

- Maximize the number of pigs per litter.
- Optimize piglet birth weight and uniformity.
- Maximize number of litters per year per sow.
- Maximize lactation yield.
- Optimize longevity and lifetime productivity by avoiding high weight loss during lactation



The recommended sow diets:

1. Flush diet: Fed from weaning to mating to stimulate ovum development.

2. Gestation Diet 1: Recovery and maintenance or older parity sow diet (lower amino acids to energy ratio). Fed after insemination till day 85 of gestation or fed to older parity sows.

3. Gestation Diet 2: Late gestation diet to enhance piglet birth weights or to develop young animals. Fed from day 85 till day 110 of gestation or fed to first parity sows.

4. Transition Diet: Fed during the transition period between gestation and lactation (from day 110 of gestation till 2-3 days after farrowing).

5. Lactation Diet: To maximize feed intake and milk yield during lactation. Fed for the duration of the lactation period.

8.4 Weight development

Managing body condition
Maternal gain is highly dependent on feeding level – excess feeding during gestation generally causes a high body weight and fatness at farrowing, which in turn will decrease voluntary feed intake during lactation (Eissen et al., 2000). This can negatively affect the sow's milk production and litter growth rates (Grandison et al., 2005). However, literature has shown that an increase in body weight for the first 35 days of gestation is important to ensure a high number of vital embryos (Beijer, 2016).

For gilts we recommend a weight gain between 60 – 70kg during gestation to ensure sufficient empty body weight at the start of lactation. This will ensure that the gilt can perform well during lactation in terms of milk production and total litter gain. Clowes (2003) mentioned that a higher empty bodyweight of gilts combined with a lower weight loss during lactation positively relates to better follicle quality. Better quality of follicles will ensure a better subsequent litter and litter performance and prevent second litter syndrome.

For sows top performance comes with ensuring the right physical condition throughout their productive life, which means that they meet the optimal weight, backfat and body condition score at farrowing and weaning as defined by Topigs Norsvin. The given bodyweight targets in Table 13 are based on optimum performance and therefore not always the lowest feed costs. The optimum will vary according to sow parity and chosen feed program.

8.5 Body composition boundaries

Table 13. Recommended body composition.

Parity	Moment	Weight		Backfat		BCS	
		Min	Max	Min	Max	Min	Max
1	Farrowing Weaning	220 180	240 200	14 10	16 12	3 2	4 3
2	Farrowing Weaning	245 200	265 220	14 10	16 12	3 2	4 3
3	Farrowing Weaning	260 220	280 240	13 10	15 12	3 2	4 3
4	Farrowing Weaning	275 230	295 250	13 10	15 12	3 2	4 3
5	Farrowing Weaning	285 240	305 260	13 10	15 12	3 2	4 3
6	Farrowing Weaning	290 245	310 265	13 10	15 12	3 2	4 3

TIP
Be cautious when using different methods of scoring like BCS, caliper when judging the condition of the TN70. The sows appear leaner than they are.

9. FEEDING & MANAGEMENT DURING BREEDING

9.1 Feeding strategies

Short-term, high-level feeding (flushing) after weaning until mating will increase the quality of the oocytes in breeding animals. Flush feeding gilts and sows has shown to increase reproduction hormones that enhances size and uniformity of the oocytes.

Important factors to consider when using flush diets:

- Energy and nutrient intake should be maximized (2.5-3.0 times maintenance requirements) between weaning and insemination by maintaining a high feed intake level.
- Specialized flush feed must be fed during this phase. The energy source of the diet must originate from a carbohydrate constituent (especially starch and sugars). It is not recommended to use a standard lactation feed.
- Dextrose can have positive effects on piglet vitality when incorporated into the flush diet. Ensure that the sows receive a minimum of 150-250 grams dextrose per day.
- The ratio between essential amino acids and lysine, and vitamin and minerals levels should follow the recommendations given for the lactating sow.
- Additional minerals and vitamins can also be provided during the flush period. Higher levels of vitamin A, E, B12 and folic acid have a positive effect on reproduction.

Do's and don'ts

Do's:

- Develop a special flush feed that is 100% focused on improving reproduction performance from weaning to mating.
- Feeding sows ad libitum requires multiple feedings per day. Feed at least three to four times a day smaller portions to increase total daily feed intake from weaning till mating.
- Sows will naturally reduce their feed intake when they are in heat.
- Reduce feed allowance to normal levels to reduce wastage.
- Provide water ad libitum but prevent wet floors.

Don'ts:

- Do not use a lactation feed as a flush feed. Lactation feeds are developed to achieve maximum milk production, not to flush sows.

Table 14. Nutrient recommendations for a flush diet.

Nutrients	Wheat-Barley-Soy		Corn-Soy	
	Min	Max	Min	Max
ADFI, kg/day	**3.5**	**4.5**	**3.0**	**4.0**
Net Energy, MJ/kg	9.5	9.7	9.7	9.9
SID Lysine, g/kg	5.9	6.1	6.1	6.2
SID Lys/NE	0.63	0.63	0.63	0.63
Starch and sugars, g/kg	400		450	
Calcium, g/kg	7.0	7.5	7.5	8.0
Available P, g/kg	3.4	3.6	3.6	3.8
Digestible P[1], g/kg	2.5	2.7	2.7	2.9

[1] The level of digestible phosphorous (g/kg) is expressed as STTD P (standard total tract digestibility) and is calculated by dividing daily requirements by daily feed intake of the animals. We recommend utilization of Phytase in order to reduce Phosphorous excretions and environmental impact.

9.2 Management during breeding

Critical success factors that contribute to good breeding management of gilts and sows:

- **Develop standard operating procedures to improve work flow.**

- **Feeding**
  - Gilts and sows should enter the breeding room in good body condition (Table 13).
  - Flush gilts and sows.
  - Clean troughs and provide fresh feed daily.

- **Water should be provided ad libitum.**

- **Hygiene**
  Transmission of infections between animals should be kept to a minimum. This can be done via:
  - Clean lying area to keep the sow clean at insemination.
  - Remove dirt on the vulva with clean paper towel.
  - Store insemination materials and semen away from dust and dirt.
  - Keep insemination materials in packaging until time of use.
  - Only touch the catheter at the end after opening the protective layer.
  - Insert foam plug into sow with avoiding that the plug touches the dry part of the vulva.

- **Climate**
  Temperature setting should be 21 °C.
  - Avoid cold or heat stress in sows.
  - Avoid draught because this is a continuous stress factor.

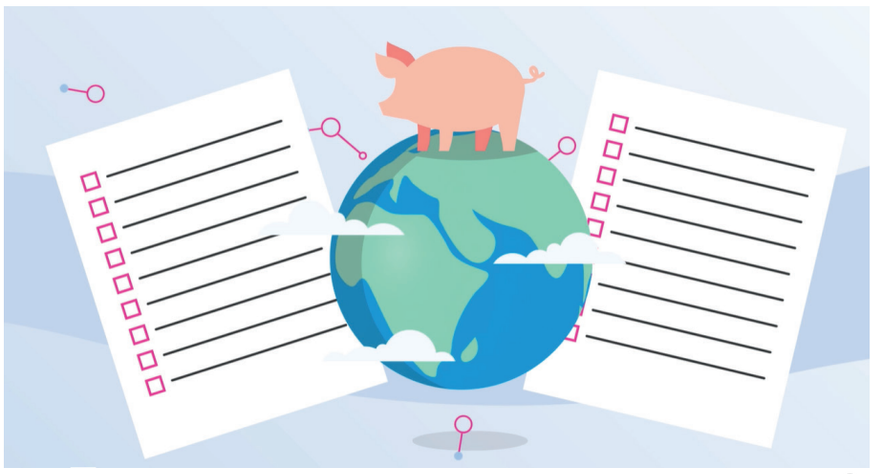
- **Lightning**
  - Topigs Norsvin advises to use >100 lux in a day-night rhythm.

- **Boar exposure**
  Apply two times each day boar exposure in the routine and start the day from weaning.
  Do boar exposure with active boars for 10 minutes each time.
  - High libido boar (for more details check page 25)
  - Age >10 months

- **Housing of the boars**
  Boar housing should be housed separately from the breeding area to avoid habituation of the females.

- **Good health status of breeding herd**
  - Monitor health status frequently in your farm.

- **Room design**
  - Special artificial insemination crates with open fronts.
  - Individual housing of sows and gilts.



10. FEEDING & MANAGEMENT DURING GESTATION

10.1 Introduction

Body weight gain during gestation is very important to ensure longevity of the breeding herd (Opschoor, Knol & Zak, 2019). Global Nutrition and Female Reproduction Services recommends a weight gain of 60-70 kg and this can be achieved by proper feeding and management during gestation which directly benefit their farrowing rate, litter size, lactation performance and piglet vitality. It is important that gestating sows receive enough protein and energy to support body maintenance and body recovery from previous lactation, and foetal and mammary growth. During gestation, sufficient body reserves must therefore be accumulated to compensate for eventual nutritional deficits that may occur in the following lactation period.

10.2 Feeding strategies

Topigs Norsvin recommends in the ideal situation two gestation diets. A diet for early and mid-gestation and a second diet for late gestation to better meet the sow's daily requirements. This offers the possibility to further enhance sow's longevity and productivity. If implementation of two gestation diets is difficult, one gestation diet can be used, but it needs to be balanced to support maternal weight gain for the younger sows and at the same time control body weight of older parities. More attention is needed for the right feed program.

The advantage of feeding two gestation diets:

1. Minimizing the overfeeding of nutrients to sows.
2. Easier to manage and control the body condition of sows.
3. Feeding two gestation diets also has economic benefits by reducing sow feed costs per year.
4. Improving sow and litter performance.

Early and mid-gestation

During the first five weeks of gestation (0-35 days), crucial processes take place such as implanting and development of embryos and development of the placenta. The sow also uses most of the feed for maintenance and to regain condition losses. Sows can loose on average 6-12% of their body weight and 2-4 mm of backfat (measured at the P2 position) during lactation. Depending on the sow's condition at weaning, the desired feed level of the individual sow must be determined after mating.

Early and mid-gestation diet:

- Contain lower amino acid to energy ratios to stimulate backfat and body weight recovery.
- Are fed directly after insemination till day 85.
- Are fed as single gestation diet to older parity sows (≥4th parity).

Late gestation

On day 85, the sow should have regained the adequate body condition, weight and backfat; so that the feed surplus can be used for piglet growth. Requirement in amino acids are increasing towards the end of gestation.

Late gestation diets:

- Have higher amino acid to energy ratio to improve piglet birth weights.
- Are fed from day 85 till day 110 (or until transfer to the farrowing unit).
- Can also be fed as single gestation diet to young sow (<4th parity).

Effect of parity on weight development

Young sows still have maternal weight gain development up to parity 3. From parity 4 on the sow reaches adult weight, so maintaining and recovering weight gain becomes more important and maternal weight gain decreases. Therefore, there is a difference in maintenance and recovery weight per parity.

Sow weight management with two gestation diets

In Table 15 an example is given how to manage a sow herd with two gestation diets to control maternal weight gain and adult sow weight with different parities.

Table 15. Multipurpose gestation diets.

	Early & mid gestation diet	Late gestation diet
Parity 1 and 2		
Parity 3		
Parity ≥ 4		
Mixed parities		

10.3 Daily nutritional requirements

Table 16. Daily nutritional requirements of gestating sows during three phases.

0-35 days

TN70				
Cycle	1	2	3	≥4
Net energy, MJ/d[1]	19.7	25.8	26.3	25.9
SID-Lysine, g/d[1]	11.3	14.2	12.4	7.9
SID Lys/NE, g/MJ	0.57	0.55	0.47	0.31

35-85 days

TN70				
Cycle	1	2	3	≥4
Net energy, MJ/d[1]	21.4	22.5	22.7	23.4
SID-Lysine, g/d[1]	13.4	9.2	7.7	6.8
SID Lys/NE, g/MJ	0.63	0.41	0.34	0.29

85-110 days

TN70				
Cycle	1	2	3	≥4
Net energy, MJ/d[1]	26.4	27.0	27.6	28.8
SID-Lysine, g/d[1]	17.9	14.1	13.4	13.3
SID Lys/NE, g/MJ	0.68	0.52	0.49	0.46

[1] Net energy (NE), Metabolizable energy (ME) and standardized ileal digestible (SID) lysine requirements are expressed as the amount required per day to achieve optimal performance. NE=ME X 0.74 (The conversion factor could be different for each country).

The gestation requirements are based on weight and backfat targets from Table 13.

10.4 Nutrient recommendations

Table 17. Nutrient recommendations for gestation diets.
Example of a Wheat-Barley-Soybean diet*

Nutrients	Gestation 1		Gestation 2	
	Min	Max	Min	Max
Net Energy, MJ/kg	8.8	9.0	9.2	9.4
SID Lysine, g/kg	4.7	4.8	5.5	5.6
SID Lys/NE	0.53	0.53	0.60	0.60
Calcium, g/kg	7.0	7.6	8.1	8.7
Available P, g/kg	3.3	3.6	3.6	3.8
Digestible P[1], g/kg	2.5	2.7	2.7	2.9
Ca:digestible P	2.8	2.8	3.0	3.0

[1] Recommended digestible phosphorus level is expressed as STTD P (standard total tract digestibility). We recommend utilization of Phytase in order to reduce Phosphorous excretions and environmental impact.
* If only one diet can be fed during gestation, our recommendation is to follow the guideline given for gestation 1. and recalculate the feed curves.

Example of a Corn-Soybean diet*

Nutrients	Gestation 1		Gestation 2	
	Min	Max	Min	Max
Net Energy, MJ/kg	9.4	9.6	10.1	10.3
SID Lysine, g/kg	5.0	5.1	6.1	6.2
SID Lys/NE	0.53	0.53	0.60	0.60
Calcium, g/kg	7.6	8.1	8.4	9.0
Available P, g/kg	3.6	3.8	3.7	4.0
Digestible P[1], g/kg	2.7	2.9	2.8	3.0
Ca:digestible P	2.8	2.8	3.0	3.0

[1] Recommended digestible phosphorus level is expressed as STTD P (standard total tract digestibility). We recommend utilization of Phytase in order to reduce Phosphorous excretions and environmental impact.
* If only one diet can be fed during gestation, our recommendation is to follow the guideline given for gestation 2 and recalculate the feed curves.

10.5 Feed curves

By dividing the energy level of the diet by the daily nutrient requirements of the sow during the three phases, a proper feed scheme can be derived. The examples of feed curves below are based on the example diet calculations. The feed curves need to be further adapted to ensure that sows regain the condition lost during the previous lactation, but also to reach the ideal condition target before entering the next lactation. This is best achieved by feeding each individual sow a well-balanced diet and basing daily feed allowances on an estimation of the sow's body weight and backfat thickness.

$$\text{Amount of feed per day} = \frac{\text{The energy requirements per day}}{\text{The energy level of the diet}}$$

Table 18. Recommended feed curves for TN70 (kg/day).

Wheat-Barley-Soybean Markets

TN70								
Days/Cycle	1		2		3		≥4	
	Min	Max	Min	Max	Min	Max	Min	Max
0-35	2.2	2.3	2.8	2.9	2.9	3.0	2.9	3.0
35-84	2.4	2.5	2.5	2.6	2.5	2.6	2.6	2.7
84-115	2.8	2.9	2.9	3.0	3.0	3.1	3.1	3.2

Corn-Soybean Markets

TN70								
Days/Cycle	1		2		3		≥4	
	Min	Max	Min	Max	Min	Max	Min	Max
0-35	2.0	2.1	2.5	2.6	2.6	2.7	2.6	2.7
35-84	2.2	2.3	2.3	2.4	2.3	2.4	2.4	2.5
84-115	2.5	2.6	2.6	2.7	2.7	2.8	2.8	2.9

The TN70 sow loses on average 8 % of her maternal body weight and 2-4 mm of her backfat during lactation. The average percentage loss is already included in the normal feed curves (Table 18).
If sows are losing more or less body weight during lactation, the gestation feed curve should be adapted to the Skinny or Fat feed curve. On day 85 of gestation, all sows should have regained their adequate body condition, weight and back fat, so that the feed surplus can be used for growth of the piglets in the uterus.

10.6 Management in the gestation unit

In the first part of gestation it is important that the females get calmness and feel safe. This is crucial because this is also the period where the implantation occurs (day 7-30 after insemination), meaning that the embryos attach to the uterine wall. In loose housing systems regrouping of sows/gilts and fighting in this period may result in lower farrowing rate and reduced litter size.

To realise a high fertility rate, which will improve productivity and efficiency of sow farms, the next items are of importance:

- Avoid moving sows between 5 days after insemination or before day 28 of pregnancy
- Avoid stress due to hierarchy fights in group housing
- Guarantee an adequate feed and water intake related to parity and body size
- Proper heat detection during gestation
- Comfortable temperature
- A stable day and night rhythm during the year (16 hours light, 8 hours dark) to avoid seasonal fertility effects.
- Predictive and calm staff that handles pigs in a good way.

Fibre and rooting material

Like all pigs, sows have an innate need to root and given the opportunity they will spend 70% of their time walking, rooting, foraging, and feeding. Sows are active and exploratory and should be provided with rooting materials to avoid stereotypies. In addition to activity, rooting materials are positive for satiety, it enables a greater feed intake during lactation, and it is positive for the intestinal microflora.

A stereotypy is a repeated, relatively invariate sequence of movements having no obvious purpose. It is a clear sign of poor animal welfare.

Access to rooting materials is positive for:

- Activity
- Satiety
- Intestinal microflora
- Feeding capacity
- Water intake
- Preparation for parturition

Rooting materials should be

- Edible
- Chewable
- Good for rooting
- Transformable

Group housing of sows

The nutritional needs of the sows housed in group systems are different from individually housed sows. When sows are housed individually the feeding can be controlled and more precisely managed for each individual animal. The following feeding and management factors need to be taken into consideration when developing diets for group housed sows.

Key factors to consider in developing diets for group housed sows:

1. Introducing gilts or sows to the group after the lactation period, could lead to stress. Antagonistic behaviour while establishing herd dominance can be observed. These events cause an undesired decrease in feed intake levels after introduction of an animal to a 'new' group. This decrease in feed intake can have detrimental effects on the pregnancy rate and also on the subsequent litter sizes. It is therefore advised to increase the individual feed allowances and to minimize any potential stress events after introducing new sows to a group.

Take care:

- More attention needs to be given to gilts and submissive sows. Always check if these animals return to the feeders (if fed more meals per day).
- Underfeeding can be a problem for animals when using a floor feeding system or crates with free access.
- Monitor the water intake of sows kept in groups since water intake levels are normally lower in group housed sows than sows kept in crates.

2. Raw materials containing fermentable and inert fibres play a very important role in feeding group housed sows. The inclusion of fermentable fibre reduces the feeling of hunger, thus increasing the satiety level in sows. Higher satiety levels do not only reduce the amount of antagonistic behaviours among sows, but will also keep sows calmer throughout the day. This could also help to prevent bottlenecks around feeders.

Take care:
- Strict attention should be paid to young sows and the time they need to consume the higher fibre diets at the individual feeding stations.

3. Sows housed in groups need excellent leg conformation, mainly because sows are moving and walking greater distances. In order to ensure strong legs the following criteria have to be met:

A. Proper gilt rearing strategies need to be established. Using gilt rearing diets which are focused on bone mineralization is essential for bone development.
B. Over-conditioned sows often have more leg problems because the weight does not match the leg conformation.
C. Minerals and vitamins, which play an essential role in bone and claw development, need to be supplied in sufficient quantities (Ca, digestible P, Ca:dP ratio, Anion:Cation balance, Mg, Zn, Mn, Se, Vitamin D3 and Biotin).
D. The counteractive interactions between minerals need to be taken into consideration when increasing the levels or changing ratios.

4. There is no optimum feed curve for sows in group housing systems. Feed curves need to be adjusted to the environmental conditions, parity, sow line, group size, health status and most importantly the body condition of the sows.

Key factors to be considered in managing sows in group housing systems:

1. Gilts should be taught how to use an electronic feeding station in the absence of older or more dominant sows. It is also generally accepted that breeding gilts should be taught to express social behaviour by exposing them to older dominant sows a few times prior to introducing them to larger sow groups.

2. Insufficient space allowance in group housed sows increases the adverse consequences of aggressive behaviour at introduction and it also induces high levels of stress. Therefore the correct space allowance for sows kept in groups should be respected.

3. Avoid moving sows around the period that embryos are attaching to the uterine wall. Rather move sows directly after insemination into their groups, or at least after 28 days after insemination. Legislation might vary from country to country.

4. Group composition should be kept as consistent as possible. Aggressiveness during the introduction of gilts into a sow group can be reduced by familiarizing gilts with older sows first. Also try to keep younger animals together during the whole gestation period.

5. Floor quality is essential in group housed sows. Avoid slippery and unhygienic floors. Bedding is proven to have positive effects in terms of production, when used in group housed systems.

11. FEEDING & MANAGEMENT DURING TRANSITION

During the transition from late gestation to lactation the sow encounters several changes. She is moved from group-housing to individual pen, diets are changed, and she will give birth to piglets. Also, colostrum is being synthesized, massive mammary gland and foetus growth occurs, and milk production is initiated. Both environmental and nutritional changes will influence the farrowing process. The farrowing process is energetically demanding, and a large litter size increases those energy demands. If this energy demand is not met during farrowing, it might result in reduced uterus contractions and prolonged duration of farrowing which increases the risk of stillbirth and deficient supply of oxygen (asphyxia).

Changing to a higher density lactation feed will require a reduction of the feed quantity to prevent udder pressure. The lower feed quantity and lower fibre inclusion can lead to the occurrence of constipation. Constipation can decrease milk production and increase the risk of mastitis. It could also lead to narrowing of the birth channel and increases the number of stillborn piglets due to a prolonged farrowing process. Feeding a higher fibre diet during the transition phase could prevent constipation around farrowing (Theil, 2015). By using a specific transition diet with higher fibre content compared to fibre content in lactation diet, the main advantage is that most of the fibre is not digested in the stomach but in the large intestine. This slower degrading of nutrients ensures that sows have a supply of energy during farrowing (because most sows decrease their feed intake when parturition approaches) compared to feeding a high energy diet.

The benefits of a transition diet:

Improved milk production.
More equal energy distribution around farrowing.
Reduced constipation around farrowing.
Lower risk of mastitis, metritis and agalactia (MMA) and udder congestion.
Improved transition between lower nutrient dense gestation diets to higher nutrient dense lactation diet.
Improved piglet vitality and survivability.

Practical tips for a good transition diet/phase

- Move sows to the farrowing crates at least 5-7 days before expected farrowing.
- Start feeding the transition diet at least 4-7 days before expected farrowing.*
- Feed the transition diet until 2-3 days after farrowing.
- Feed at least or more than 2 times a day.
- Ensure that similar raw materials are being used in the gestation, transition and lactation diets to minimize the stress of a diet change.
- Use the right fibre sources during gestation, transition and lactation. Some fibres will give a more laxative effect (hulls), whereas others will bring more consistency (Barley effect) and others will have fermentative effect (beet pulp).
- Add the right components to protect and boost the liver (Choline, L-carnitine and B vitamins)
- Optimize the dEB content of the gestation, transition and lactation diets.
- Minimize all stressors around farrowing and avoid medication if possible.
- Make sure the sow has easy access to plenty of fresh water (See chapter Water).

* Over the world, different ways of feeding sows from gestation to lactation by transition feeding is done. In Norway, the recommendation is to change at least 21 days before expected farrowing to a transition diet.

11.1 Nutrient recommendations

Table 19. Nutrient recommendations for a transition diet.

	Transition (day 110 – day 2-3 post farrowing)
ADFI, kg/day*	**2.9-3.3**
Net Energy, MJ/kg	9.3-9.7**
SID Lysine, g/kg	6.3-6.6
SID Lysine:NE	0.68
Ca, g/kg	7.5-8.1
Available P, g/kg	3.3-3.5
Digestible P[1], g/kg	2.5-2.7
Ca:Digestible P	3.0

[1] The level of digestible phosphorous (g/kg) is expressed as STTD P (standard total tract digestibility). We recommend utilization of Phytase in order to reduce Phosphorous excretions and environmental impact.

* Average daily feed intake varies based on condition and parity of the gilts/sow

** Lower energy values are recommended if feed intake is good

Producers not using a transition feed should make sure to decrease the feed allowance 1-2 days before parturition and give roughage in this period to maintain bowel movement and avoid constipation; and of course, ad lib water in excess.

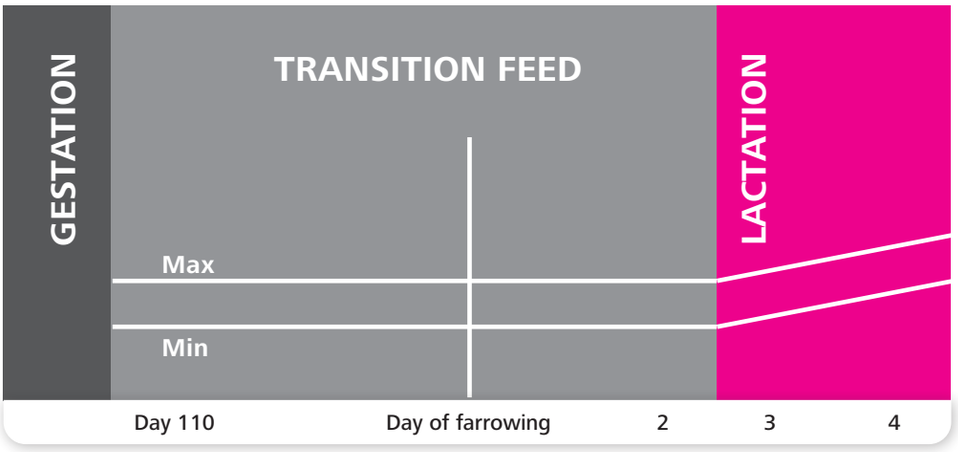
11.2 Feed curves

The advantage of feeding a transition diet is that you can increase the feed allowance before farrowing without any negative effects on udder development and start-up of milk production (Feyera et al., 2021). Feeding higher volumes of the transition diets around farrowing is also a way to prevent constipation and may result in more relaxed sows.

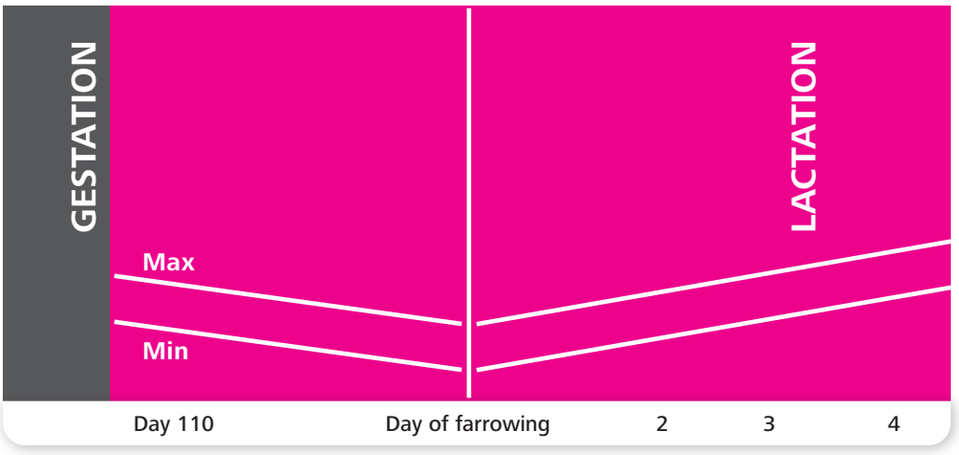
The objective is to keep the daily energy intake at least the same at the end of gestation up to farrowing. The ideal feed amount during transition will thus depend on the density of the transition feed/lactation feed.

Excessive feed intake during the pre-farrowing period can result in too much milk production that leads to udder congestion and can also lead to further tissue damage. If high levels of protein/ energy (such as in the lactation diet) are fed, udder development can be rapid and too excessive in the immediate period leading up to farrowing. The failure of newborn piglets to "milk out" the sow will lead to pressure build-up in the udder, damaging the milk producing cells and thus compromising milk yield during the entire lactation period.

Recommended feed curve when using a transition diet



Recommended feed curve when no transition feed is used



12. FEEDING AND MANAGEMENT DURING LACTATION

12.1 Introduction

Sows with sufficient body reserves at breeding and farrowing, together with adequate feed intake in lactation, will have significantly lower body weight loss in lactation and therefore improved oocyte quality. Body weight loss should be restricted to 6% and definitely stay below 12%. The improved oocyte quality will improve next litter performance in terms of litter gain (Opschoor, Knol & Zak, 2019).

The TN70 sow is a leaner breed which means the amount of body reserves might be limited if proper care has not been taken during rearing and gestation. If this is the case, the sow will start mobilizing her own maternal body tissue. A high water and feed intake during lactation is therefore crucial to ensure a high milk production, good litter gain and prevent high body weight loss. Remember that the sow needs four litres of water to produce one litre of milk. The appropriate amount of nutrients must be available for the sow's milk synthesis. This shows the importance of the nutritional and management factors to support the sow's lactation performance.

12.2 Feeding strategies

The main purpose of the feed program for the TN70 is to maximize milk production without increasing substantial losses in body condition that subsequently might impair reproductive performance.

The nutritional requirements for the TN70 are based on estimated production levels. An indicator for production performance of lactating sows is litter weight gain. The estimated litter weight gain is between 3.1 kg/day and 3.5 kg/day. It is important to measure and registrate piglet litter weight at birth and weaning to determine the nutrient requirements of the sows. The sow's nutrient requirement during lactation is dependent on the lactation length. The norms used in this feed manual are 21, 28 and 35 days of lactation.

Topigs Norsvin litter weight gain calculation
Litter weight gain (kg/day) = (Litter wean weight (kg) - (Number piglets to be nursed x Average birth weight of piglets (kg))) / Lactation length (days)

12.3 Daily nutritional requirements

Table 20. Daily nutritional requirements of lactating sows.

21 days lactation period

Litter gain kg/day	Nutrient Requirements	Parity		
		1	2	≥3
3.1	Net energy, MJ/day[1]	70.2	70,0	69.7
	SID-Lysine, g/d[1]	66.5	65.1	63.1
	SID Lysine/Net energy, g/MJ	0.95	0.93	0.91
3.3	Net energy, MJ/day[1]	74.4	74.2	73.9
	SID-Lysine, g/d[1]	70.6	69.1	67.2
	SID Lysine/Net energy, g/MJ	0.95	0.93	0.91
3.5	Net energy, MJ/day[1]	78.6	78.4	78.1
	SID-Lysine, g/d[1]	74.7	73.2	71.3
	SID Lysine/Net energy, g/MJ	0.95	0.93	0.91

[1] Net energy (NE), Metabolizable energy (ME) and standardized ileal digestible (SID) lysine requirements are expressed as the amount required per day to achieve optimal performance. NE=ME X 0.74 (The conversion factor could be different for each country).

28 days lactation period

Litter gain kg/day	Nutrient Requirements	Parity		
		1	2	≥3
3.1	Net energy, MJ/day[1]	70.1	69.9	69.6
	SID-Lysine, g/d[1]	66.2	64.9	62.9
	SID Lysine/Net energy, g/MJ	0.94	0.93	0.90
3.3	Net energy, MJ/day[1]	74.3	74.1	73.7
	SID-Lysine, g/d[1]	70.2	68.9	66.9
	SID Lysine/Net energy, g/MJ	0.95	0.93	0.91
3.5	Net energy, MJ/day[1]	78.5	78.3	77.9
	SID-Lysine, g/d[1]	74.3	73.0	71.0
	SID Lysine/Net energy, g/MJ	0.95	0.93	0.91

[1] Net energy (NE), Metabolizable energy (ME) and standardized ileal digestible (SID) lysine requirements are expressed as the amount required per day to achieve optimal performance. NE=ME X 0.74 (The conversion factor could be different for each country).

35 days lactation period

Litter gain kg/day	Nutrient Requirements	Parity		
		1	2	≥3
3.1	Net energy, MJ/day[1]	70.0	69.8	69.4
	SID-Lysine, g/d[1]	65.9	64.7	62.7
	SID Lysine/Net energy, g/MJ	0.94	0.93	0.90
3.3	Net energy, MJ/day[1]	74.2	74.0	73.6
	SID-Lysine, g/d[1]	70.0	68.7	66.8
	SID Lysine/Net energy, g/MJ	0.94	0.93	0.91
3.5	Net energy, MJ/day[1]	78.4	78.2	77.8
	SID-Lysine, g/d[1]	74.0	72.8	70.8
	SID Lysine/Net energy, g/MJ	0.94	0.93	0.91

[1] Net energy (NE), Metabolizable energy (ME) and standardized ileal digestible (SID) lysine requirements are expressed as the amount required per day to achieve optimal performance. NE=ME X 0.74 (The conversion factor could be different for each country).

12.4 Nutrient recommendations

Sows with large litters produce more milk and have a higher litter gain. Therefore, they also have higher nutrient requirements compared to sows with smaller litters. Reaching litter weight gains of 3.5 kg/day highly depend on:

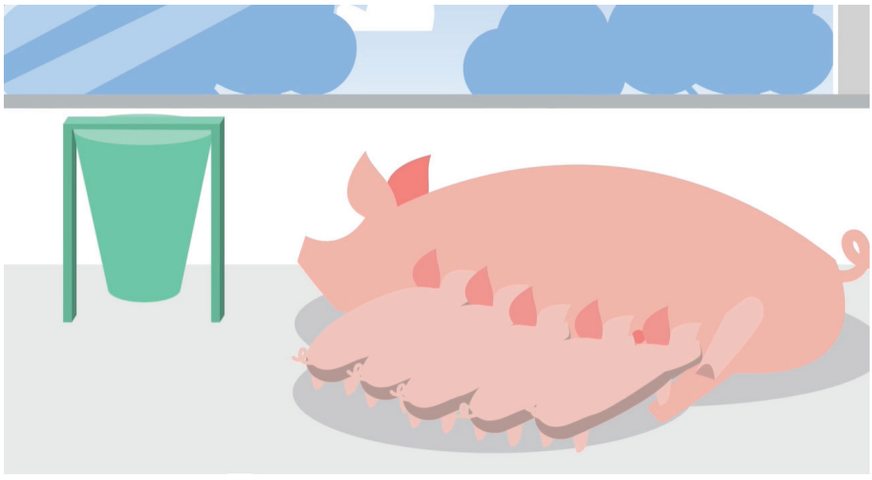
1. Total litter size
2. Lactation feed intake
3. Density of diet
4. Piglet feed intake

The actual litter weight gain and daily feed intake of the sow should be known to design lactation diets because nutrient requirements and diets are based on daily litter weight gain and lactation length. Diet calculations are based on the average of second and third parity sows.

Table 21. Nutrient recommendations for lactation diet.

Nutrients	Wheat-Barley-Soy		Corn-Soy	
	Gilts	Sows	Gilts	Sows
Liter gain (kg/day)	3.1		3.1	
ADFI, kg/day	6.0	6.7	5.5	6.2
Net Energy, MJ/kg	10.0	9.7	10.6	10.3
SID Lysine, g/kg	9.3	9.0	9.9	9.6
SID Lys/NE, g/MJ	0.93	0.93	0.93	0.93
Ca, g/kg	9.9	9.3	10.2	9.6
Available P, g/kg	4.4	4.2	4.5	4.3
Digestible P[1], g/kg	3.3	3.1	3.4	3.2
Ca:Digestible P	3.0	3.0	3.0	3.0

[1] Recommended digestible phosphorus level is expressed as STTD P (standard total tract digestibility). We recommend utilization of Phytase in order to reduce Phosphorous excretions and environmental impact.



12.5 Feed curves

Feed refusal incidents should be minimized during the first 8 days of lactation period; therefore, the recommended feed curve is moderately conservative in the beginning. By slowly increasing the feed allowance in the first part of the lactation, the overall feed intake is increased during lactation. Feed levels from day 8 on should be maximized.

Table 22. Feed schedule during lactation (kg/day).

Days	Wheat-Barley-Soy		Corn-Soy	
	Gilts	Sows	Gilts	Sows
0	2.0	2.5	2.0	2.0
1	2.3	3.0	2.3	2.5
2	2.8	3.5	2.6	3.0
3	3.3	4.0	3.1	3.5
4	3.8	4.5	3.6	4.0
5	4.3	5.0	4.1	4.5
6	4.3	5.0	4.1	4.5
7	4.8	5.5	4.6	5.0
8	5.3	6.0	5.1	5.5
>8	Ad lib	Ad lib	Ad lib	Ad lib

[#] The feed amount around farrowing and the first days after farrowing depend on whether a transition diet is being used or not. If a transition diet is being used, begin with the recommended feed curve as soon as the diet change has occurred.

Do's:

- Two to four meals per day is recommended to ensure higher feed and water intakes.
- Make sure the provided feed is always fresh.
- Controlled feeding is not restricted feeding. Managing the feed intake during lactation will improve sow performance and reduce feed wastage.
- Automated feed delivery systems are an easy manner of managing ad libitum feeding.
- Ad libitum access to good quality water.

During the first 8 days of the lactation period, it is advised to control the feed curve for lactating sows (regardless of parity). If the feeding system or farm layout does not allow more controlled lactation feeding, we recommend controlling at least the first 2-3 days after farrowing. After this period the sows can be fed ad libitum. However, keep monitoring the feed intake, feed refusal and appetite of the sows. We also recommend providing the sow with additional water during the first days after farrowing because after farrowing the sows are less motivated to drink enough water. The water requirement of the sow increases with increasing milk production milk production. If possible, provide ad libitum water (see chapter Water).

Do's to ensure optimal appetite during lactation:

- Always use fresh, never stale, dirty or contaminated feed.
- Pellets give better intake than meal.
- Liquid feeding: hygiene control is extremely important to ensure maximum feed intake.
- Increase daily feed allowance gradually, thus matching the sows' nutritional needs with feed levels.
- Avoid over-conditioned sows at the beginning of lactation.

12.6 Management in the farrowing unit

Nutrition, management, and health are the key success factors in the farrowing unit. The goals of this particular phase are: high number of live born piglets, low number of stillborn piglets, low pre-weaning mortality, high litter gain which results in high litter weight at weaning. To make sure that the quality of the next litter will not be compromised, sows should be managed to avoid high weight loss. The success factors of management are split up in three categories: before, during, and after farrowing.

Before farrowing:

- Sows need to be transferred 5-7 days prior to farrowing to the farrowing unit.
- Sows need to be put into a washed, clean and dried pen.
- It is preferred to use a transition diet which is high in fibre to prevent constipation around farrowing.
- Feed the sows 3x per day to ensure good energy distribution that the sow will need during farrowing.
- Socialized gilts and sows in the farrowing pen will help the staff in their daily activities and their safety.
- Use strict pen hygiene during entire lactation (for example removal of manure, placenta, and feed).

During farrowing:

- Make sure sows have access to nest building material 12 hours before farrowing.
- Avoid stressed sows during farrowing, for example: free farrowing units or adjusted crates.
- Spacious farrowing pens with good creep areas for the piglets.
- It is important to keep an eye on the sows that are farrowing and if necessary, provide maternity care.
- Be sure that all piglets get enough colostrum (approximately 250 g).
- Predictable and calm staff will prevent stressed sows during the farrowing process.
- The use of protocols to work systematic will improve the farrowing process.
- In case of big litter size, split suckling can be applied to support colostrum intake for all piglets.

After farrowing:

- Feed the sows 3x per day preferably to increase overall feed intake.
- Adjust the feed level stepwise at least until day 6 after farrowing.
- Optimal feed program during lactation is adapted according to sow's condition and number of piglets to avoid under- or overfeeding.
- Keep a close eye to the sow's appetite after increasing the feed level.
- Availability of microclimate for piglets to avoid hypothermia.
- Cross fostering 24 hours after birth to ensure sufficient colostrum intake.
- To guarantee a good start of the litter, treatments of piglets needs to be done after day 3.
- Provide creep feed from week 1 to the piglets so they get slowly used to solid feed.
- Count functional teat of the sow to optimize nursing capacity.

It is important regarding climate to meet the needs of both sows and piglets. A microclimate can help adapting the climate specifically for piglets. This can be done via:

- Floor heating
- Piglet nests
- Lamps

In Table 23 temperature guidelines microclimate for piglets are shown.

Table 23. Miroclimate guidelines for piglets in lactation.

	Temperature (°C)
0-7 days	33-35
8-24 days	29-31
≥ 25 days	23-26

12.7 Group housing and free farrow systems

In modern pig housing, aggression between pigs is usually due to competition for resources such as food, water, and resting area. A group-housing system should therefore be designed with individual feeding stalls allowing all sows to feed simultaneously and ensure that no sow can monopolise access to the feed or steal feed from others. In fight for resources, size does matter, and it is therefore recommended that sows are sorted into smaller groups with sows of similar age and size.

Resting areas must be large enough so all sows can lie down all at once. The resting area should be comfortable with good ventilation and be organized in a manner ensuring that they are not disturbed by other sows. Sows prefer to rest with their backs against a supportive wall.

Space requirements

Space restrictions is one of the most obvious potential problems in modern pig housing. The farrowing crates were made to make management easier, and they are more space efficient, however they inhibit the sows from expression of natural behaviour. In Norway, Sweden, and Switzerland the farrowing crate has been prohibited for many years. The two most common systems for free farrowing in Norway are pens with no crates at all or pens with crates for short-term use. Knowledge and experience brought the development/practice in the direction from smaller pens (1.8-2.0 m x 3.0 m) and short-term use of crates to larger pens (minimum 2.4 m with x 3.2 m length) with no opportunity for crating. The size of the farrowing pen is essential, they must be big enough for the sow to turn around freely and enable her to communicate with her piglets and push them out of the way before lying down. The sow needs a circle of minimum 2.0 m free from equipment. If the pens are made to small this will lead to more crushing of piglets. It is also important to have protection rails on the pen walls to support the sow and protect the piglets from crushing when the sow lays down. If made correctly, free farrow systems lead to more liveborn, fewer stillborn and more piglets weaned. These systems also have lower pre-weaning mortality, higher weaning weights and healthier sows. Free farrow systems also allow for nest building which shortens the farrowing duration and reduces the number of stillborn piglets.

A well-functioning and comfortable creep area for the piglets is important in loose house systems. The creep area should be dimensioned so that all piglets in a litter can lie down simultaneous throughout the lactation period (1.4 m2). The creep area should be covered by a lid and have heated floor. To optimize workflow and staff safety the creep area should be placed toward the aisle. It is also smart to have an integrated and adjustable barrier plate that can contain the piglets in the creep area when handled.

12.8 Climate in the sow unit

Environment, and more specifically temperature, can be used to explain the majority of the variation associated with differences in feed intake and performance of sows. The thermal neutral zone is the range of temperature in which the sows are comfortable and do not require additional or reduced energy intake to maintain body temperature. For gestating sows it is relatively easy to assess and maintain an environmental temperature range in which production levels are optimal. The thermal neutral zone for gestating and lactating sows is between 16-22 °C.

Climate guidelines

Table 24. Climate guidelines according to Klimaatplatform Varkenshouderij (2021)

Category	Min. ventilation per pig (m3/hour)	Max. ventilation per pig (m3/hour)	Start temperature ventilation (°C)
Empty sows	18	150	20
Pregnant sows	25	150	20
Pre-farrowing sows	25	250	23
Lactating sows 7 days *	35	250	20
Lactating sows 21 days*	60	250	20

* When microclimate is used in farrowing room, room temperature can be decreased with 2 °C.

Remarks:
- Ventilation guidelines depend on used ventilation system, animal behaviour, health status and feed intake.
- Stable/climate system is designed to avoid draft.
- Ammonia concentration should be lower than 20 ppm measured in resting state of the animal.

Heat stress

Heat stress can have a major impact on sow performance. If the temperature in the sow barn surpasses 25 °C, this can lead to lower feed intake, reduced milk production, higher body weight losses, decreased weaning weights and poor reproductive performance. Below are a few tips to reduce heat stress during summer months by the diets.

Tip:
Make sure that sows have free access to water.

Reduce the amount of internal heat produced by the diet
- Fibre digestion and the protein deamination process generate considerably more heat compared to carbohydrates. Therefore, consider reducing dietary fibre levels by 1-2% (depending on initial concentration). Compensate for the reduction in dietary fibre by supplementing it with a strong laxative (usually in the form of a magnesiumsalt). Also consider reducing crude protein levels by about 2% with the supplementation of industrial amino acids to maintain the same ratios of SID AA's:SID Lysine.

Increase the nutrient density of the diet
- The main idea is to increase the nutrient density of the lactation diet in relation to the expected reduction in feed intake. Increase the levels of the vitamins, minerals, and trace minerals in relation to the drop in the expected feed intake. The drop in feed intake can easily be between 5 to 10 % during summer.

- Lactation diets higher in fat are almost invariably recommended for combating heat stress. Although it is a good strategy to increase fat levels to 5-6 %, it also poses a potential risk. Higher levels of dietary fat increase the chance for oxidation which can lead to rancid feed. This would even further decrease feed intake. Discuss with your feed company, what would be the best strategy to administer fat into the diets to increase the caloric density.

Increase feeding frequency
- Increase the feeding frequency and decrease portion size to minimize metabolic heat production. Sows also drink more water under warm conditions, and excess feed in the troughs will spoil more easily if left in water for longer periods. Left-over feed + water + heat = Reduced sow feed intake.
- Shift feedings to the early mornings and late afternoons.
- Try to feed at least three to four times during summer. Always start with a clean trough.
- Try not to feed more than 2.5 kg per feeding.

Keep free water low in summer diets
- Free water can be measured in diets as the nutrient AW (Available Water). The recommended level should be below 0.5.
- High amounts of 'free water' in diets could lead to higher mold/toxin levels and could also lead to excessive evaporation in feed tanks (which can cause blockages in the feed lines).

Feed additives for summer diets
- The concentration and/or inclusion of certain additives cannot be altered due to country-specific regulations. In the list below are additives that have demonstrated, in research, to reduce heat stress and increase feed intake in lactating sows. Discuss the possibilities and correct inclusion levels with your feed company.

The following additives could be used during summer to increase lactation performance:
- Chromium Propionate/Picolinate
- L- Carnitine
- Betaine or Choline Chloride
- Sodium bicarbonate (don't forget to optimize the electrolyte balance)
- Antioxidants (Also Vit E, Se and Vit C)
- Liver support (B-complex vitamins, Niacin, Citric and Fumaric acid)
- Magnesium Oxide (as laxative)

Cold stress
During the winter, cold stress can be both a nutritional and management issue. The temperature in the sow barn should match the sow's thermal neutral zone. Cold temperatures increase the maintenance requirements of the sows, and it is therefore recommended to increase the dietary energy levels (MJ NE/day) during the cold season. Depending on the density of the diet, a five degree Celsius drop in temperature, relative to the thermal neutral zone, increases the daily dietary needs of the sows with 0.15-0.20 kg. This translates into increasing the energy supply to sows with 0.4-0.5 MJ NE per degree when temperatures below 18 °C are reached (Table 25). Besides the higher amount of energy needed per sow per day, it is also recommended to adapt the sow diets during the cold season. The energy in the diet can be adjusted, so more energy comes from starch and less from oil/fat; which would all together influence fertility positively. Increasing the fermentable fibre content of the gestation diet, keeps the sows satiated and can improve the feed intake during the upcoming lactation. Moreover, fermenting fiber produces heat in the large intestine which helps the sows to cope better with the cold weather.

Table 25. Additional feed needed for changes in temperature.

Room temperature	Additional feed MJ NE/day
> 18 °C	advice
16 °C.	+1 MJ
14 °C.	+2 MJ
12 °C.	+3 MJ

Systems to reduce heat stress in the sow unit
Pigs do not have sweat glands and thermoregulation is a challenge for them. A good environment is essential to offer sows with comfortable temperatures. There are multiple systems known for reducing heat stress in sows and help them to control their temperature. Some examples are:

- Cooling system with the use of evaporation of water. There are two ways to do this:
  - Pad cooling: incoming air is moistened passively.
  - High or low pressure misting: incoming air is charged with moisture via pressure.
    N.B. Be careful that relative humidity is not increased, because this increase causes obstruction of the cooling effect.

- Drip cooling: this system cools down the animal instead of the air.
  - Sprinklers

- Air blowers: a cooling effect is created by a permanent flow of air around the animal.
  N.B. Do not use air blowers in farrowing rooms, because high air speeds cool piglets which may cause diarrhoea.

- Pad cooling for lactating sows: heat from the sow, when she is lying down, is conducted to a sink.

12.9 Amino acid, vitamin and mineral requirements for sows

Amino acid requirements
The amino acid requirements for gestating and lactating sows are given in Table 26.

Table 26. Amino acid requirements for the TN70 sow*.

Amino acid profile*	Gestation				Lactation	
	Gilts		Sows		Gilts &Sow	
	Min	Max	Min	Max	Min	Max
SID Lysine	100	100	100	100	100	100
SID Methionine	36	39	37	39	30	33
SID M+C	65	70	68	71	55	60
SID Tryptophan	18	20	19	20	19	20
SID Threonine	70	72	75	79	65	66
SID Valine	71	76	75	79	75	82
SID Isoleucine	60	67	60	66	58	60
SID Leucine	100	101	102	106	114	115
SID Histidine	32	35	32	35	40	42
SID Phenylala-nine	58	60	60	62	56	60
SID Phenyl. + Tyr	102	104	100	102	113	119
SID Arginine	113	115	100	102	100	103

* The recommended amino acid profile was compiled based on various resources like CVB (2020), FEDNA (2013), NRC (2012) and practical experience of our nutrition team.

Vitamin and mineral requirements
The vitamin requirements are given in Table 27 and the mineral requirements are given in Table 28 for gestating and lactating sows.

Table 27. Vitamin requirements for the TN70 sow*.

Vitamins	Units	Gestation		Lactation	
		Min	Max	Min	Max
Fat soluble vitamins					
Vitamin A (Retinol)	IU	10000	12000	10000	12000
Vitamin D3 (Cholecalciferol)#	IU	1800	2000	1800	2000
Vitamin E	mg	80	150	100	
Vitamin K3 (Menadione)	mg	4.5	6.0	4.5	6.0
Water soluble vitamins					
B1 (Thiamine)	mg	2	3	2	3
B2 (Riboflavin)	mg	6	10	6	10
B3 (Niacin)	mg	35	70	35	100
B5 (Pantothenic acid)	mg	25	40	25	45
B6 (Pyridoxine)	mg	3.5	6.0	3.5	6.0
B7 (Biotin)	mcg	300	800	300	800
B9 (Folic acid)	mg	4.0	6.0	3.0	5.5
B12 (Cyancobalamin)	mcg	30	50	30	100
C (Ascorbic acid)	mg	+	300	+	300
Choline (Betaine)	mg	500	800	500	1000
L-carnitine	mg		50		50

* The vitamin requirements were compiled based on various resources like BASF, DSM (2016), FEDNA (2013), LFL (2019), NSNG (2010), NRW (2016) and practical experience of our nutrition team.
# The level of these vitamins should be adjusted taking into account to the local legislation and own objectives.

Remarks:
- Use of minimal 50% vitamin D in the form of 25(OH)D3 as recommended by Global Nutrition and Female Reproduction Services.
- Vitamin D inclusion levels are focused to support maximization of bone mineralization and optimal performance and not necessarily the lowest feed costs.
- The recommended vitamin standards are the amounts added without considering the contribution of raw materials.

Table 28. Mineral specifications for the TN70 sow*.

Minerals	Units	Gestation		Lactation	
		Min	Max	Min	Max
Na	%	0.20	0.30	0.25	0.30
K	%		1.30		1.30
Mg	%	0.25	0.50	0.25	0.50
Fe	mg	100	200	100	200
I	mg	1	2	1	2
Se	mg	0.3	0.5	0.3	0.5
Cu	mg	15	25	15	25
Zn	mg	110	150	110	150
Mn	mg	50	100	50	100
Cl	%	0.15		0.15	
dEB (Na + K - Cl)	meq/kg	240		190	

* The minerals requirements were compiled based on various resources like FEDNA (2013), LFL (2019), NSNG (2010), NRW (2016) and practical experience of our nutrition team.
# The level of these minerals should be adjusted taking into account to the local legislation and own objectives.

Remarks:
- Mineral inclusion levels are focused to support maximization of bone mineralization.
- The recommended mineral levels are presented as total amount in the feed.
- The recommendation of Topigs Norsvin is to use organic or chelated minerals as recommended by the suppliers.
- The target dEB (Na+K-Cl) for sow diets is to ensure maximum bone mineralization.

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14. APPENDIX

14.1 Backfat measurement instructions

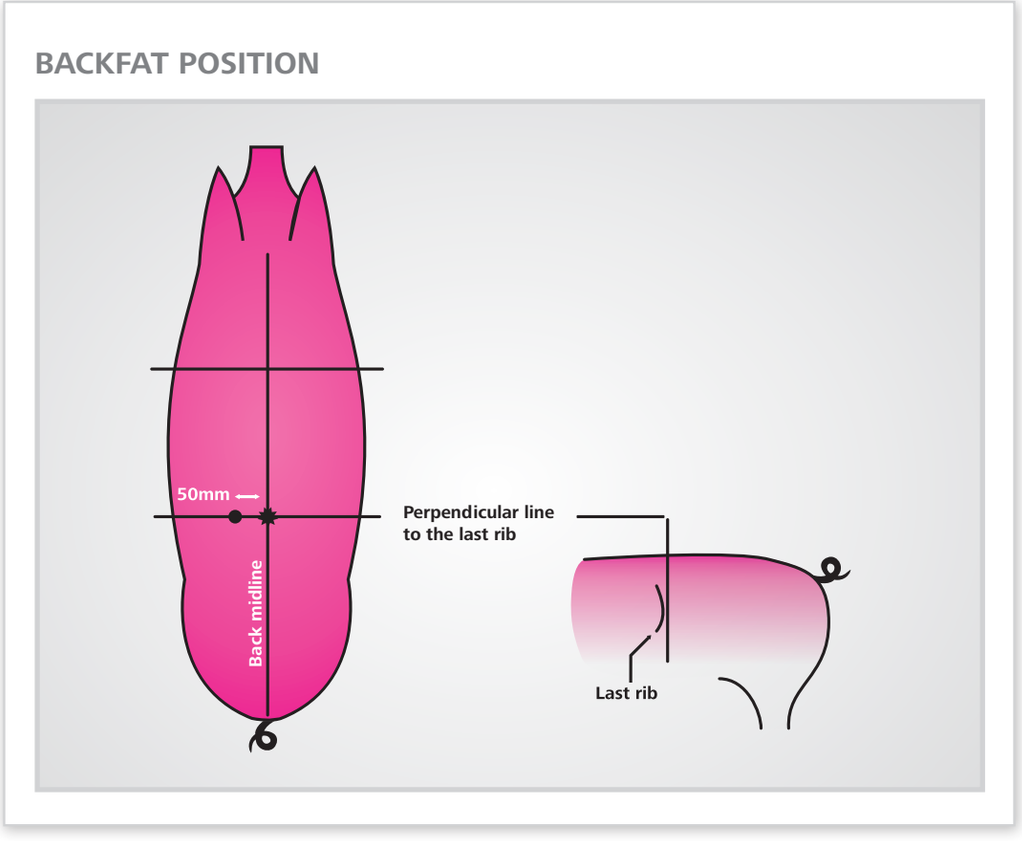
Consistency of probe placement is of great importance in obtaining comparative measurements. The procedure must be performed while the pig is standing. The animal must be restrained in a stall, scale, or walkway to simplify handling.

To locate the P2 site and measure backfat the following must be done:

- Find the rearmost edge of the last rib on the pig's left hand side.
- Mark a spot vertically above on the midline.
- From this spot, measure 50 mm down the left side from the midline.
- Place the probe of the ultrasound machine directly over the P2 site according to the manufacturer's instructions and record the fat measurement (a contact solution is usually required to get an accurate reading).
- It is important to record two layers of backfat.

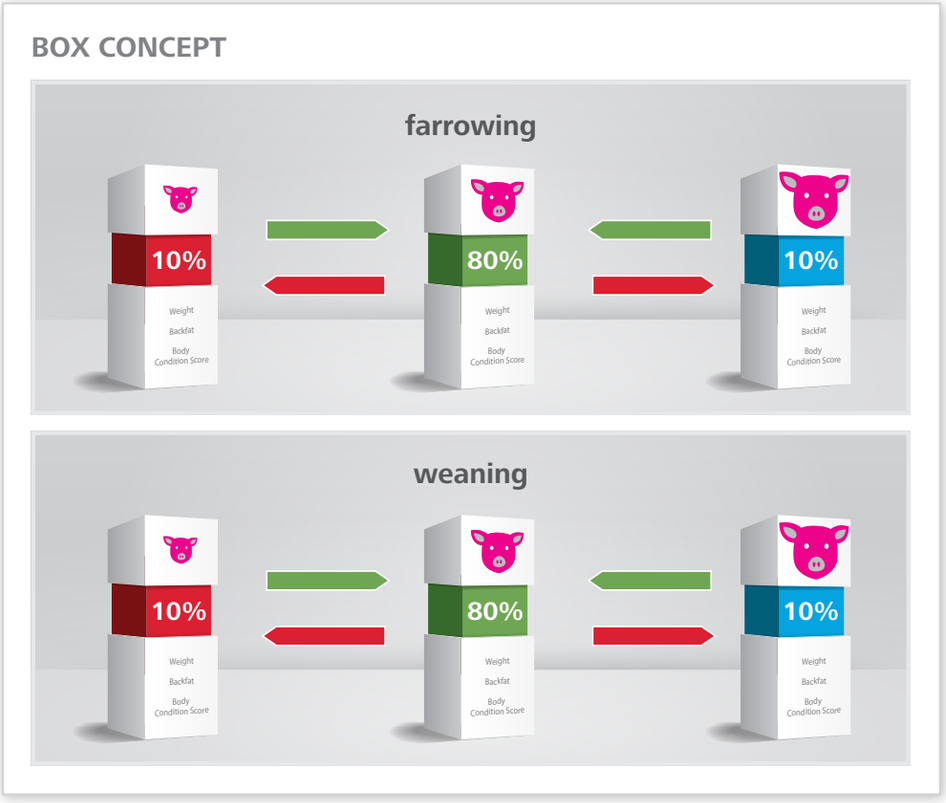
There are several producers of backfat meters thus it is very important to measure the backfat according to the manufacturer's instructions.

Figure 1. Topigs Norsvin P2 backfat position.



14.2 The box concept

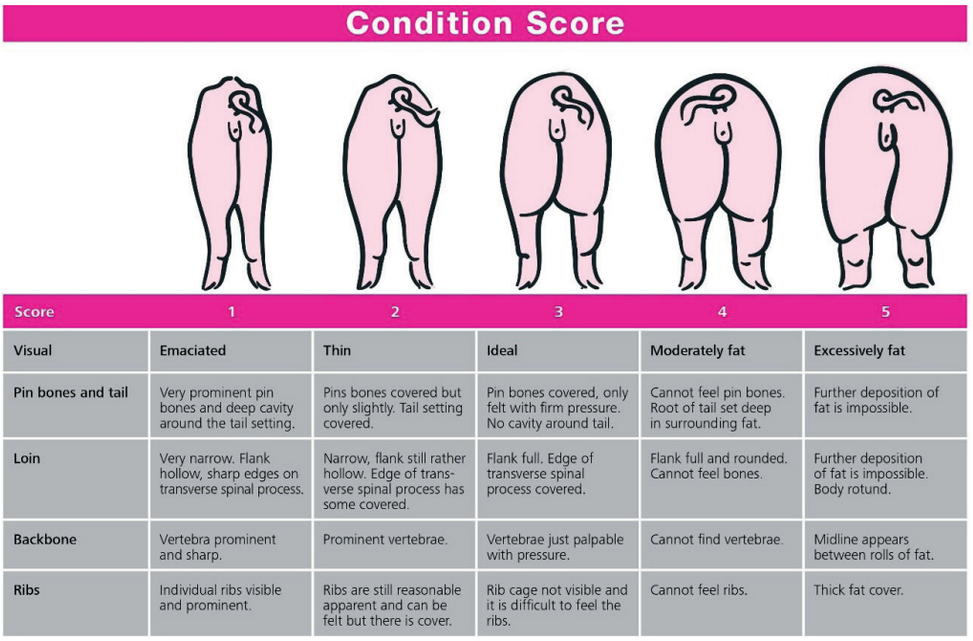
The Topigs Norsvin box concept should be seen as body condition boundaries for sow weight, sow backfat and sow body condition score (BCS). The main objective is to get the Topigs Norsvin sow inside the green box (normal condition ranges) or in other words, within the recommended boundaries for weight, backfat or BCS at farrowing and at weaning. The target is to get 80% of all sows in the green box at farrowing and at weaning and thereby improving sow herd uniformity and overall sow herd performance and efficiency.



14.3 Body Condition Score

With the help of Figure 2, the body condtion score (BCS) of gilts and sows can be determined at different stages of production.

Figure 2. Body Condition Score of gilts and sows.



Score	1	2	3	4	5
Visual	Emaciated	Thin	Ideal	Moderately fat	Excessively fat
Pin bones and tail	Very prominent pin bones and deep cavity around the tail setting.	Pins bones covered but only slightly. Tail setting covered.	Pin bones covered, only felt with firm pressure. No cavity around tail.	Cannot feel pin bones. Root of tail set deep in surrounding fat.	Further deposition of fat is impossible.
Loin	Very narrow. Flank hollow, sharp edges on transverse spinal process.	Narrow, flank still rather hollow. Edge of transverse spinal process has some covered.	Flank full. Edge of transverse spinal process covered.	Flank full and rounded. Cannot feel bones.	Further deposition of fat is impossible. Body rotund.
Backbone	Vertebra prominent and sharp.	Prominent vertebrae.	Vertebrae just palpable with pressure.	Cannot find vertebrae.	Midline appears between rolls of fat.
Ribs	Individual ribs visible and prominent.	Ribs are still reasonable apparent and can be felt but there is cover.	Rib cage not visible and it is difficult to feel the ribs.	Cannot feel ribs.	Thick fat cover.

If you have any questions about the manual,
please contact Global Nutrition and Female Reproduction Services.
gnfrs@topigsnorsvin.com

www.topigsnorsvin.com

Topigs Norsvin