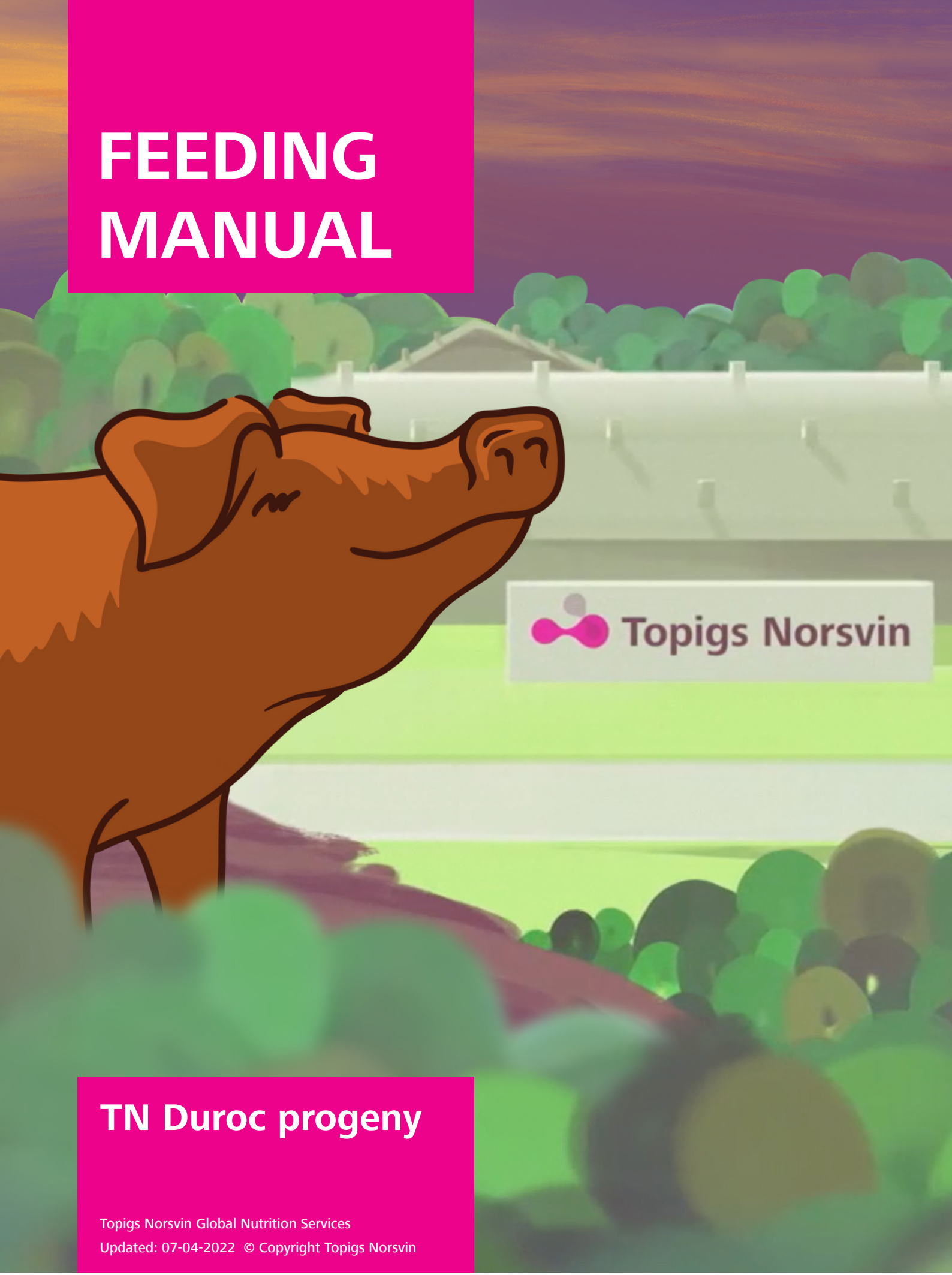
FEEDING MANUAL



TN Duroc progeny

Topigs Norsvin Global Nutrition Services
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7 Appendix

1. Example of diet calculations for Wheat-Barley market

2. Example of diet calculations for Corn-Soy market

3. Amino acid/Lysine ratio used to estimate amino acid requirements

4. Standardized ileal digestible vs. Apparent ileal digestible lysine

5. Vitamin and mineral recommendations

6. Phosphorus

1. INTRODUCTION

Progress in Pigs. That is what Topigs Norsvin stands for. We are continuously improving our genetics to enable our clients to stay ahead. Our goal is to unlock the maximum potential of our genetics for all customers, and to enable them to achieve the best possible performance results. Nutrition is one factor to unlock this potential, therefore Global Nutrition Services gives advice and develops protocols, tools, and manuals.

This manual was developed by the Global Nutrition Services team to be used in professional pig production. We want to thank Felleskjøpet, Harpers Adams University and Zoetis for their contribution to this manual.

2. THE AIM OF THE MANUAL

The aim of this manual is to provide a feeding guide based on the nutritional requirements of the TN Duroc progeny to achieve an optimum genetic performance, calculated in terms of daily gain and feed conversion. Daily gain is described in this manual as the sum of protein and fat deposition. Use of maximum genetic performance will result in optimal growth and minimal feed conversion ratio. Maximum growth can be achieved only when the nutrients, specifically amino acids, and energy, are supplied in the diet at the appropriate amount.

The recommendations in this manual are based on protein and fat deposition. Protein and fat deposition is influenced by factors like sex, age, feed intake, health status and genetic line. In pig growth models, the deposition of protein and lipid mass is often used to describe compositional pig growth, and these can be estimated separately. The table results in this manual are derived from our own Pig Growth Model® developed by Topigs Norsvin Research Center (TNRC, 2019) and from the analysis of field data under various environments. This manual can only be used for Topigs Norsvin genetics.

3. TYPOLOGY, CHARACTERISTICS OF TN DUROC

TN Duroc is our terminal boar for producers looking for the combination of production efficiency and pork quality suitable for export.

Progeny of TN Duroc boars differentiate themselves in the market through:

- High feed efficiency
- More robust finisher
- Lower finishing mortality
- High carcass yields
- Suitable for ad-lib feeding

TN Duroc is naturally robust and feed efficient. Compared with the competition, use of TN Duroc lowers finishing mortality with 1%, allowing you to deliver more pigs to market, and produces carcasses with 0.5% higher carcass yield.

4. DAILY NUTRITIONAL REQUIREMENTS

4.1 Basic assumptions

TN Duroc finishers are capable of high protein deposition and high growth rates. High performance is achieved with the right diets which need to cover the daily requirements of the animals. The daily requirements given in this manual are based on Pig Growth Model® (TNRC, 2019) and the validation data was collected in Topigs Norsvin nucleus and test farms.

The daily requirments in this manual are based on:

- Multi-phase feeding
- Castrates, gilts and boars fed ad libitum
- Dry pelleted diet, with dry matter of 88% (using pelleted feed improves the digestibility of the diet and the daily intake)
- Conventional/high health
- Sexes housed and fed seperately
- Ideal ambient temperatures

4.2 Daily nutritional requirements TN Duroc progeny

Due to relatively low feed intake in the starter/grower phase (or early finishing), and their high capacity for protein deposition, diet formulation and management strategies should focus on increasing nutrient intake during this stage.

Table 1. Daily nutritional requirements and weight development curves of TN Duroc finishers.

Days in	Castrates			Gilts			Boars		
	BW, kg	NE, MJ/day[1]	SID Lys, g/day[1]	BW, kg	NE, MJ/day[1]	SID Lys, g/day[1]	BW, kg	NE, MJ/day[1]	SID Lys, g/day[1]
1	25.0	10.8	14.1	25.0	10.5	14.1	25.0	9.8	14.0
8	29.9	13.0	16.0	29.9	12.6	16.0	30.1	12.1	15.6
15	35.9	15.3	17.7	35.9	14.8	17.7	36.2	14.5	17.6
22	42.5	17.7	19.2	42.5	17.1	19.2	43.0	16.9	19.4
29	49.7	20.1	20.4	49.6	19.4	20.4	50.3	19.3	20.9
36	57.3	22.3	21.3	57.1	21.5	21.3	58.1	21.5	22.1
43	65.3	24.4	21.8	65.0	23.5	21.8	66.4	23.4	22.9
50	73.5	26.3	22.1	73.1	25.2	22.1	74.9	25.1	23.4
57	82.0	27.6	22.0	81.4	26.4	22.1	83.7	26.5	23.6
64	90.5	28.9	21.7	89.8	27.6	21.8	92.5	27.7	23.5
71	99.1	29.9	21.2	98.2	28.5	21.3	101.4	28.6	23.2
78	107.7	30.7	20.5	106.6	29.2	20.6	110.2	29.3	22.7
85	116.1	31.2	19.7	114.8	29.7	19.9	118.9	29.9	22.0
92	124.3	31.6	18.7	122.9	30.0	19.0	127.4	30.3	21.1
99	132.4	31.9	17.8	130.7	30.2	18.0	135.6	30.6	20.2
106	140.2	32.0	16.8	138.2	30.3	17.0	143.5	30.9	19.2

[1] Net energy (NE) and standardized ileal digestible (SID) lysine requirements are expressed as the amount required per day to achieve optimal performance. Based on the TNRC Pig Growth Model® (2019).

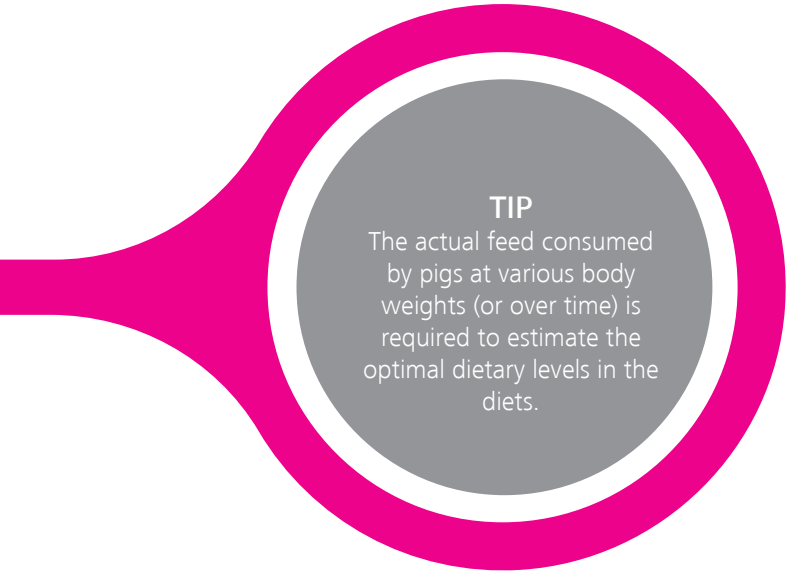
5. FEEDING AND MANAGEMENT

5.1 Introduction

To achieve the highest performance possible, Topigs Norsvin provides the daily requirements for genetic potential in this manual. However, the genetic potential is influenced by different environmental factors. In this chapter we will describe the most important factors which will affect the performance during the finisher phase.

5.2 Feed intake: Ad libitum vs. Restricted feeding

The daily feed intake of a finisher will be the key determinant for the feed industry to design a proper feed program, which will give the farmer the highest economic return. Due to the variation in feed intake, Topigs Norsvin presents the requirements to their clients as energy and digestible lysine per day, as given in this manual.



Feed intake is affected by feed type and quality, management, health status and housing. So, when pigs are fed ad libitum, the estimation of actual intake is also a reflection of their appetite under the prevailing conditions.

TN Duroc finishers have a good feed intake capacity, and they are still efficient from 75 kg body weight onwards. At a certain point during the finisher phase there will be a shift towards lower protein deposition and higher fat deposition. Consequently, back fat thickness will slightly increase, and lean meat percentage will decrease. But, due to the genetic progress in feed efficiency and gain in TN Duroc, there is less need to control the feed intake during the latter part of the finishing phase. However, controlling energy intake will lead to better lean meat percentages but this can limit the maximum growth performance compared to ad libitum feed systems.

5.3 Health conditions

The efficiency of nutrient utilization in pigs is optimized under high health environments. A high health status not only increases productivity and efficiency, but also leads to an increased nutrient demand. When pigs are immunologically challenged, nutrients are diverted away from productive functions (i.e. lean tissue growth) towards the activated immune system. Therefore, under conventional health situations (most farms in the world), the immune system of the animal has to cope with all kinds of pathogens. This can have an influence on the amino acid profile requirements of the challenged animals especially for Met + Cys, Thr and Trp (Kampman-Van de Hoek, 2015).

Under SPF conditions the animals can increase their feed intake with 10-15%, reduce maintenance requirements with approximately 10%, and increase protein deposition capacity with around 25g/d.

The following points need to be taken under consideration for SPF animals:

- SPF animals grow faster; therefore, they have the capacity to reach higher protein deposition rates.
- The higher feed intake capacity in SPF animals is not reflected by an increased protein deposition level, if the SID lysine to energy ratio's in the diet is limited.

5.4 Paylean® (Ractopamine)

Ractopamine-HCl is regulated by local legislation, please check the guidelines before using it. Ractopamine-HCl, is an adrenergic agonist and is labelled for use in swine diets during the final growth stages. Dietary inclusion has shown consistent improvement in pig growth performance and has led to its widespread use in the swine industry. When fed, it promotes lean growth rather than fat deposition by directing nutrients away from the fat depots towards muscle development.

Fat tissue deposition requires more energy than lean growth, thus increasing lean deposition leads to improved feed efficiency prior to market and a leaner carcass. Because of the increased protein accretion, pigs that are fed Ractopamine have an increased dietary amino acid requirement.

Beside the advantages of using Ractopamine, there are some attention points which should be considered. Topigs Norsvin recommends to strictly follow the nutritional guidelines of the specific manufacturer when using these additives.

5.5 Immunization against boar taint (Zoetis)

Immunization against gonadotropin-releasing hormone (GnRH) for controlling boar taint and sexual boar behaviour has been introduced to the global market as an animal-welfare-friendly alternative to surgical castration. The Immunization is licensed globally. The first dose of the injection primes the pig's immune system but does not alter testes functionality. The second dose stimulates the protective immune response resulting in a temporary inhibition of testicular development.

Until the second injection the animal remains a boar. After the second Immunization the testicular hormone release is blocked (for about 10 weeks) inducing a physiological transition to a castrate-type animal.

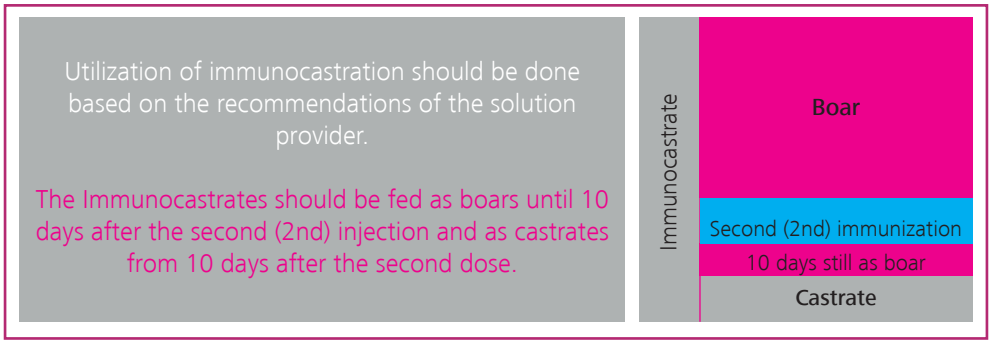
After 10 to 14 days transition period following the second injection, the average daily feed intake (ADFI) of the immunized animals increases dramatically. Because of the significant increase in ADFI that occurs starting two weeks after the second injection, **feeder space and feed availability must be prioritized for these immunized animals.**

This increase in feed consumption results in a significant increase in lipid deposition rate, and the overall Feed:Gain advantage of immunocastrates begins to decline (by 1.5 to 2.0% per week with each additional week after the second dose (Puls, 2013)). However, the immunized animals continue to be more efficient than physically castrated males up to at least seven weeks after the second dose. At the same time, belly yield and bacon slicing characteristics improve as time after the second injection increases (Boler et al., 2012). Therefore, it will be imperative for each production system to balance live performance and carcass characteristic goals to maximize the profit potential from this technology.

Nutritional guidance

To optimize ADG and Feed:Gain, it is recommended that SID Lysine and other amino acids levels for boars immunized against boar taint be increased to the same requirement for non-immunized entire boars until 10 days after the second dose and to the same requirement for physically castrated animals from 10 days after the second dose to market. Energy-density before and after the 2nd immunization needs to be adapted in a way that animals do not limit themselves in intake and can be fed ad libitum.

How to feed immunocastrates:



5.6 Pellet vs. Mash feed

The feeding behaviour and performance of pigs can also be influenced by the feed type (pellet vs. mash). Feeding pelleted diets to pigs have shown an increase in nutrient digestibility and an improvement of FCR between 5-8% in finishing pigs. Improvements in animal performance have also been attributed to decreased feed wastage, reduced selective feeding, decreased ingredient segregation in the feed bin or feeder, less time and energy expended for feed intake, destruction of pathogens like entero's, thermal modification of starch and protein, and improved palatability.

The improvements in FCR highly depend on pellet quality, fines percentage and pellet size.
Another advantage of using pelleted diets is the opportunity to grind grains to smaller micron sizes and to use a higher percentage of alternative ingredients in the diets while still maintaining good feed flowability.

5.7 Hot climates

The environment can serve as a significant factor affecting both the voluntary feed intake level and the overall nutrient requirements of pigs. Temperature, probably more than any other environmental factor, explains most of the variations associated with differences in feed intake and performance among groups of pigs. Given the fact that animals tend to eat less when temperature rises, feed intake capacity can be a limiting factor for optimal performance. Swine diet formulations should be adjusted to account for the variations in feed intake associated with environmental temperature changes.
Some alternatives can be used to optimize the performance in hot climates. Under heat stress, pigs reduce their feed intake to reduce their heat production due to the thermal effect of feed (TEF). The reduction of feed consumption results in a decrease of growth of pigs which affects the profitability of the swine producers. Nutritional solutions can mainly be described according to their ability to reduce dietary heat increment or to increase dietary nutrient density. The increase of crude protein supply is associated with a higher protein turnover which enhances heat production.

Tips for coping with hot climates:

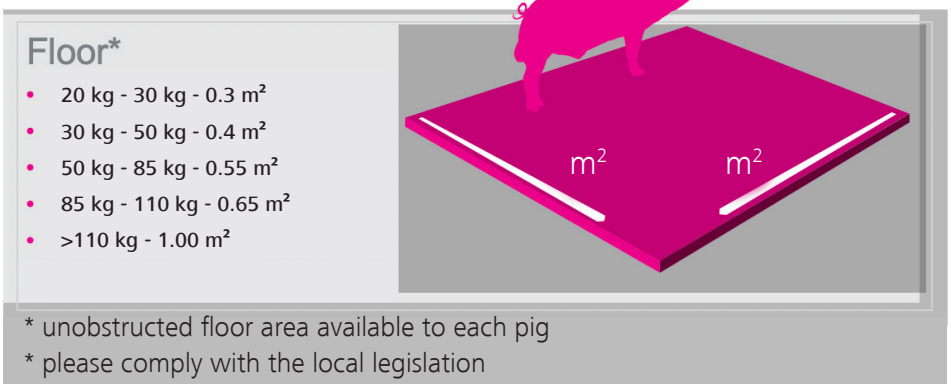
- Low crude protein diets. A practical solution is to partially replace crude protein with starch and/or fat and industrial amino acids to meet the protein requirement for optimal performance.
- Offer the feed during cooler phases of the day/night.
- Increase the number of daily feedings which will lower the energy needed for digestion (internal heat production).
- Ensure the availability of fresh clean water. Water should be available ad libitum. Ensure a minimum flow rate of 1.5 litres water per minute.

5.8 Stocking Density

The stocking density is very important for the overall performance and the welfare of the herd. Not complying with the minimum stocking densities will have an effect on overall performance.

High stocking density can lead to:

- Decreased average daily gain and feed conversion
- An increase in agonistic behaviour between pigs due to crowding, especially if there is also a lack of resources such as feed, water and/or resting space
- Less sociable pigs with damaging behavior towards pen mates
- Increased losses
- Impaired locomotion
- More dirty pens



5.9 Rooting material

Pigs are active and exploratory and will spend 70-80% of their active time rooting and investigating their surroundings. Lack of stimulation can lead to stereotypic and/or damaging behaviours such as belly nosing, tail biting and ear biting. These are not aggressive behaviours, but occur due to crowding and stimulus-poor environments. We therefore recommend that fattening pigs are provided with rooting material daily. Hay and straw are by far the best choices.

Rooting materials should ideally be:

- Ingestible
- Chewable
- Odorous
- Deformable and destructable

5.10 Liquid feeding

Working with liquid feeding systems requires certain precautions. For each type of diet there is an ideal dilution, which depends on the ingredients used and how they were included. There can be decomposition into sub-products which do not have proper time to be incorporated to the liquid diet, losses of vitamins and essential nutrients can also occur. When considering the type of grain to include in the feed, it is important to consider the chemical composition and the effects that the raw materials can have on the digestibility. Therefore, Topigs Norsvin advises regular laboratory analyses of the feed to guarantee that the pigs are not fed diets that can limit their performance and/or affect the carcass quality negatively.

5.11 Split sex feeding

In general, gilts will consume less feed and are about 4% more efficient in converting feed to body weight gain during the finishing period compared to castrates. To offset the reduction in feed intake, diets for gilts need to contain higher nutrient levels (namely protein or amino acids) to achieve adequate daily intakes of these nutrients. Boars are even more efficient than gilts.
The differences in feed intake, together with the differences in performance and carcass parameters, provide the basis for split-sex feeding.

5.12 The advantages of using fibres

Extra added fibre like soy hulls, wheat middlings, or others like oat hulls, sunflower meal and beet pulp can help to increase satiety, improve digestion, and limit negative impact of rapid hind gut fermentation in older finishing pigs. It is also important to use different type of fibres, fermentable and unfermentable. The right combination is essential for good results.

Inclusion examples:

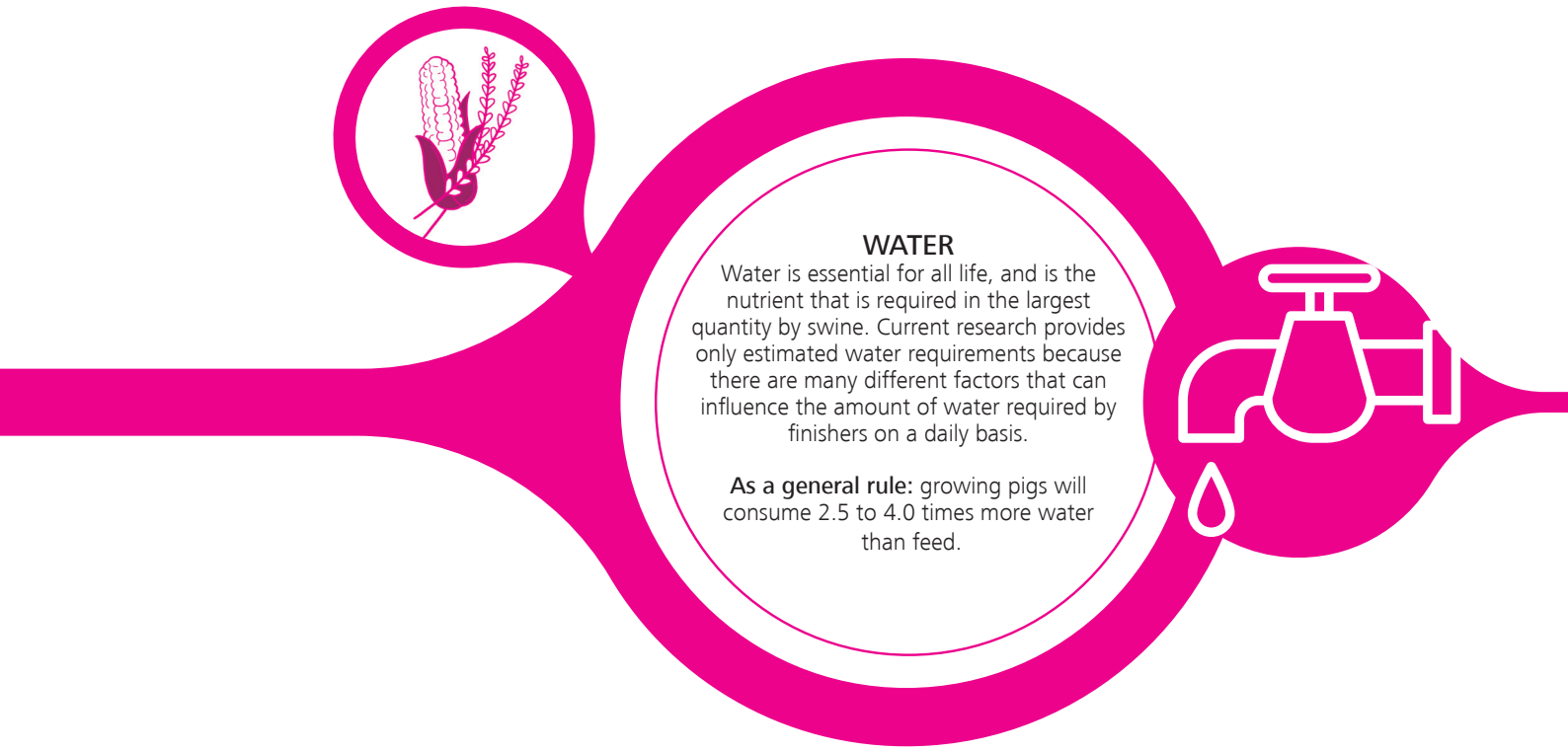
- Adding 2% soy hulls in the diets up to 70 kg live weight, and then increase the inclusion up to 5-7% in the finishing phase
- Wheat middlings - up to 5%

5.13 Temperature and ventilation

Ensure proper ventilation rates. TN Duroc sired pigs are high performing animals with high feed intake levels. Such high performing animals have an increased body heat production, and if stocking densities are too high this will affect the temperature in the pen. From research, it is known that at higher temperatures the density of pigs per m^2 should be decreased as this is also correlated with the behaviour of animals in terms of lying pattern and activity (Spoolder et al., 2012). Depending on the farm and the systems used, temperature should be adjusted to keep the animals in their comfort zone.

5.14 Water

Water is essential for all life and is the nutrient that is required in the largest quantity by swine. Water is required for tissue maintenance, body growth, thermoregulation, mineral homeostasis, excretion of metabolites and antinutritional substances, achievement of satiety and behavioural purposes. Water requirements will depend on temperature, health status, diet, and age (body weight). 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, increased stress, more urinary tract infections and a lower tolerance for disease. Poor water access and quality is also considered as risk factors for tail biting occurrences and prolapses.



Water management

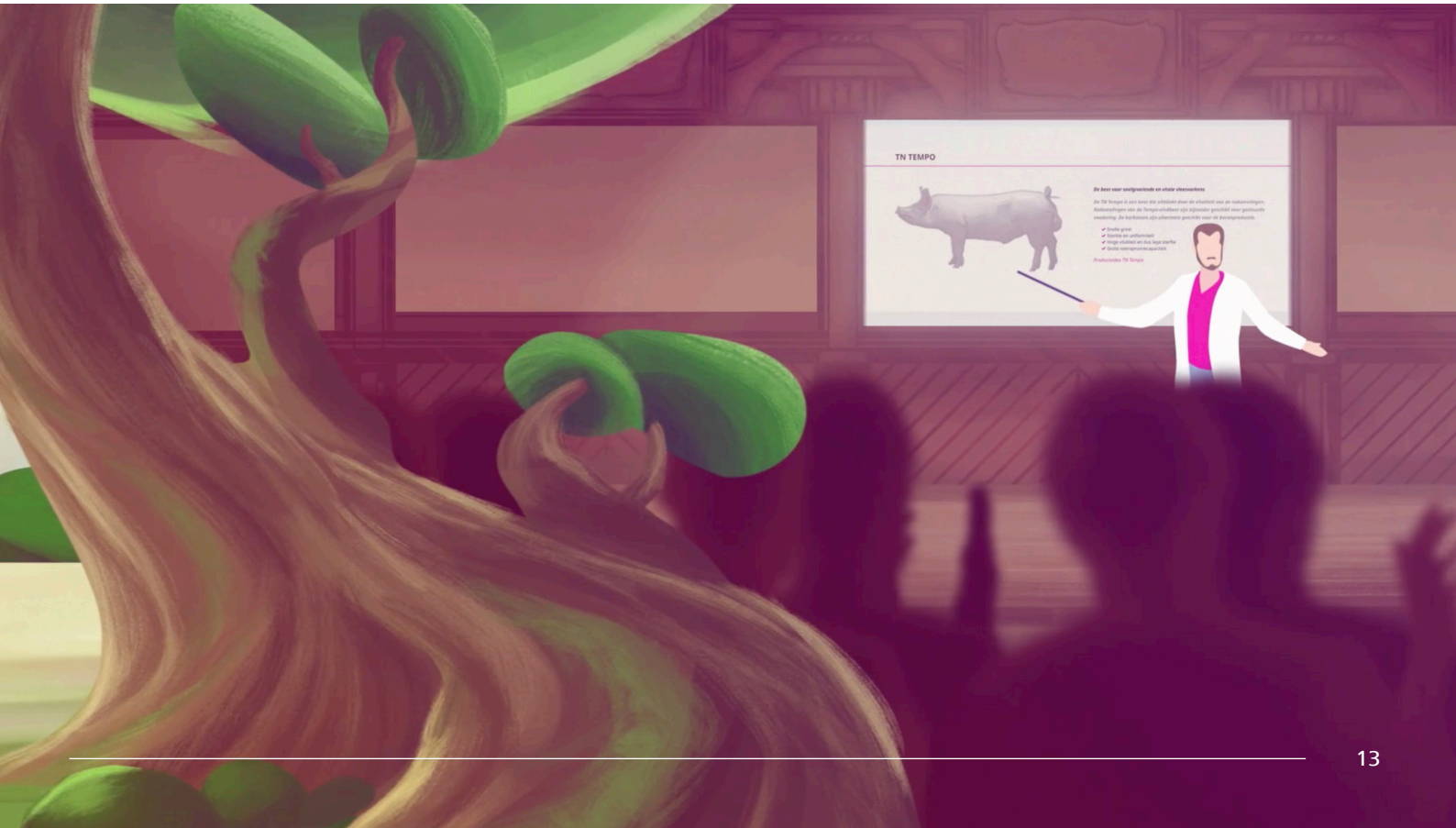
Regardless of whether you have a liquid feed system or a dry feed system, water should always be freely accessible 24h a day. Water nipples should be placed in a height appropriate for the age and size of the pigs, preferably use the shoulder of the smallest pig to determine the height.
Drinkers should 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. Local guidelines advise 5-7 pigs per drinker (Norwegian Food Authority, 2021). Always check the national legislations of your country.

Water volume and pressure

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. 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 (>1.0 liter per minute, (Brede, 2006)) is used.

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 with regards to quality standards.



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7. APPENDIX

1. Example of diet calculations for Wheat-Barley market

Wheat-barley and corn-soybean are the two main feed markets in the world. Pigs fed well-balanced wheat-barley based diets can perform as well as those fed corn-soybean diets. The minimum energy levels reachable when using these two different feed sources is what differentiates these two markets. Therefore, the feed schedules and calculations will be different for these two markets. Nevertheless, the daily nutrient requirements of TN Duroc finishers are the same.

Table 2. Example of diet calculations (g/kg) for TN Duroc finishers, based on a 5-phase feeding

Sex	Body Weight (kg)	Starter	Grower 1	Grower 2	Finisher	Final
		25 - 35	35 - 55	55 - 75	75 - 100	100 - 130
Castrates	**Ave Daily feed intake, kg/day [1]**	**1.3**	**1.9**	**2.5**	**2.9**	**3.3**
	NE, MJ/kg [2, 3]	10.0	9.9	9.8	9.7	9.3
	ME, Mcal/kg [2, 3]	3.20	3.17	3.14	3.10	2.97
	SID Lys, g/kg [2]	12.3	10.3	8.8	7.5	6.1
	SID Lys/NE, g/MJ	1.22	1.04	0.89	0.77	0.66
	Ca, g/kg	8.8	8.2	7.2	6.5	5.6
	Available P, g/kg [4, 5]	4.6	4.3	3.7	3.6	3.3
	Digestible P, g/kg [4, 5]	3.5	3.2	2.7	2.4	2.1
Gilts	**Ave Daily feed intake, kg/day [1]**	**1.3**	**1.8**	**2.4**	**2.8**	**3.2**
	NE, MJ/kg [2, 3]	10.1	9.9	9.8	9.6	9.3
	ME, Mcal/kg [2, 3]	3.23	3.16	3.14	3.07	2.99
	SID Lys, g/kg [2]	12.8	10.7	9.1	7.8	6.3
	SID Lys/NE, g/MJ	1.26	1.08	0.93	0.81	0.67
	Ca, g/kg	9.1	8.4	7.4	6.6	5.9
	Available P, g/kg [4, 5]	4.8	4.4	3.8	3.6	3.4
	Digestible P, g/kg [4, 5]	3.6	3.2	2.7	2.4	2.2
Boars	**Ave Daily feed intake, kg/day [1]**	**1.2**	**1.8**	**2.3**	**2.8**	**3.2**
	NE, MJ/kg [2, 3]	10.3	10.1	10.0	9.8	9.4
	ME, Mcal/kg [2, 3]	3.29	3.24	3.19	3.14	2.99
	SID Lys, g/kg [2]	13.3	11.2	9.7	8.5	6.9
	SID Lys/NE, g/MJ	1.30	1.11	0.98	0.87	0.73
	Ca, g/kg	9.5	9.0	7.8	7.1	6.0
	Available P, g/kg [4, 5]	5.1	4.7	4.1	3.9	3.5
	Digestible P, g/kg [4, 5]	3.8	3.5	2.9	2.6	2.2

[1] Average daily feed intake was used to calculate the nutrients per kg feed.

[2] Net energy (MJ/kg), Metabolizable energy (Mcal/kg) and SID Lysine (g/kg) are calculated based on the ADFI (kg/d).

[3] NE = ME X 0.74 (The conversion factor could be different for each country); MJ = Mcal X 4.184.

[4] The level of calcium (g/kg) is focussed on bone quality, the level can be adjusted if the objective is optimal gut health.

[5] 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.

[6] Definitions of available and digestible phosphorus are indicated in Appendix 6.

2. Example of diet calculations for Corn-Soy Market

Corn-soybean and wheat-barley are the two main feed markets in the world. Pigs fed well-balanced corn-soybean based diets can perform as well as those fed wheat-barley diets. The minimum energy levels reachable when using these two different feed sources is what differentiates these two markets. Therefore, the feed schedules and calculations will be different for these two markets. Nevertheless, the daily nutrient requirements of TN Duroc finishers are the same.

Table 3. Example of diet calculations (g/kg) for TN Duroc finishers, based on a 5-phase feeding

Sex	Body Weight (kg)	Starter	Grower 1	Grower 2	Finisher	Final
		25 - 35	35 - 55	55 - 75	75 - 100	100 - 130
Castrates	**Ave Daily feed intake, kg/day [1]**	**1.3**	**1.8**	**2.4**	**2.8**	**3.1**
	NE, MJ/kg [2, 3]	10.3	10.2	10.1	10.0	10.0
	ME, Mcal/kg [2, 3]	3.29	3.28	3.24	3.20	3.20
	SID Lys, g/kg [2]	12.6	10.7	9.1	7.8	6.6
	SID Lys/NE, g/MJ	1.22	1.04	0.89	0.77	0.66
	Ca, g/kg	9.0	8.5	7.4	6.7	6.0
	Available P, g/kg [4, 5]	4.7	4.4	3.9	3.7	3.6
	Digestible P, g/kg [4, 5]	3.6	3.3	2.8	2.5	2.2
Gilts	**Ave Daily feed intake, kg/day [1]**	**1.2**	**1.8**	**2.3**	**2.7**	**3.0**
	NE, MJ/kg [2, 3]	10.3	10.2	10.1	10.0	9.7
	ME, Mcal/kg [2, 3]	3.28	3.27	3.22	3.19	3.12
	SID Lys, g/kg [2]	13.0	11.0	9.4	8.1	6.5
	SID Lys/NE, g/MJ	1.26	1.08	0.93	0.81	0.67
	Ca, g/kg	9.2	8.6	7.6	6.8	6.1
	Available P, g/kg [4, 5]	4.9	4.6	3.9	3.7	3.5
	Digestible P, g/kg [4, 5]	3.7	3.3	2.8	2.5	2.3
Boars	**Ave Daily feed intake, kg/day [1]**	**1.2**	**1.8**	**2.3**	**2.7**	**3.0**
	NE, MJ/kg [2, 3]	10.3	10.2	10.1	10.0	9.9
	ME, Mcal/kg [2, 3]	3.29	3.27	3.24	3.21	3.17
	SID Lys, g/kg [2]	13.3	11.3	9.9	8.7	7.3
	SID Lys/NE, g/MJ	1.30	1.11	0.98	0.87	0.73
	Ca, g/kg	9.5	9.1	8.0	7.2	6.4
	Available P, g/kg [4, 5]	5.1	4.8	4.1	4.0	3.8
	Digestible P, g/kg [4, 5]	3.8	3.5	3.0	2.7	2.4

[1] Average daily feed intake was used to calculate the nutrients per kg feed.

[2] Net energy (MJ/kg), Metabolizable energy (Mcal/kg) and SID Lysine (g/kg) are calculated based on the ADFI (kg/d).

[3] NE = ME X 0.74 (The conversion factor could be different for each country); MJ = Mcal X 4.184.

[4] The level of calcium (g/kg) is focussed on bone quality, the level can be adjusted if the objective is optimal gut health.

[5] 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.

[6] Definitions of available and digestible phosphorus are indicated in Appendix 6.

3. Amino acid/Lysine ratio used to estimate amino acid requirements

Lysine is the first limiting amino acid in most swine diets. It is common practice to first define the adequate lysine level in the diet and then derive the required level of other essential amino acids based on an ideal protein ratio, thus giving a balanced protein diet. A balanced protein diet contains sufficient levels of each essential amino acid to meet the biological needs of the animal while minimizing the amounts of excess amino acids. The latest review by Peet-Schwering and Bikker (2018) has defined the ideal balance of amino acids for each phase of production based on the concept of Ideal Protein. This serves as basis for Topigs Norsvin recommendations. Feed ingredients have different amino acid digestibility coefficients. Therefore, when formulating diets that are more complex, it is recommended that standardized ileal digestible (SID) values are used in the formulation process.

Table 4. Recommendations for SID essential amino acids other than lysine in starter, grower, and finisher pig diets (expressed as % of SID lysine) for current and future growing and finishing pigs and the variation in the SID essential amino acid to lysine ratios in the reviewed literature (Peet-Schwering and Bikker, 2018).

Amino Acids[1]	Starterdiet	Grower diet	Finisher diet	Variation
Lysine	100	100	100	-
Met + Cys[2]	60	61	62	58-63
Tryptophan	20	20	20	17-23
Threonine	66	67	68	61-74
Valine	67	67	67	64-72
Isoleucine[3]	53	53	53	50-54
Leucine	100	100	100	100-102
Histidine	32	32	32	32-32
Phenylalanine+Tyrosine[4,5]	95	95	95	94-100

1 The daily gain of the future growing and finishing pigs is 10% higher than the daily gain of the current growing and finishing pigs and is realized by a 10% higher feed intake or a 10% improved feed conversion ratio;
2 A minimum ratio of methionine to methionine+cystine of 55% is advised;
3 Recommendation in diets without blood products (non-excess level of leucine);
4 Based on experiments with weaned piglets;
5 A minimum SID phenylalanine to lysine of 54% and a maximum SID tyrosine to lysine ratio of 40% to support maximal growth is advised.

4. Standardized ileal digestible vs. Apparent ileal digestible lysine

The terminology used to describe the bioavailability and ileal digestibility of amino acids in pig feed ingredients are explained in this appendix. Ileal digestibility values may be expressed as apparent ileal digestibility (AID), standardized ileal digestibility (SID), or true ileal digestibility (TID). These terms are used to specify how ileal endogenous amino acids (AA) losses are reflected in digestibility values. Ileal endogenous AA losses may be separated into basal losses, which are not influenced by feed ingredient composition, and specific losses, which are induced by feed ingredient characteristics such as levels and types of fibre and anti-nutritional factors. Values for AID are established when total ileal outflow of AA (i.e., the sum of endogenous losses and no digested dietary AA) is related to dietary AA intake. A concern with the use of AID values is that these are not additive in mixtures of feed ingredients. This concern may be overcome by correcting AID values for defined basal endogenous losses of AA, which yields SID values. Furthermore, if the AID values are corrected for basal and specific endogenous losses, then values for TID are calculated. However, reliable procedures to routinely measure specific endogenous losses are not yet available. It is suggested that SID values should be used for feed formulation, at least until more information on TID values becomes available.

Table 5. Example of the differences between SID and AID Lys for TN Duroc castrates.

		25 - 50 kg	
SID Lysine and AID Lysine	Basal (g/kg DM)	SID Lysine	AID Lysine
Lysine	0.040	1.000	0.964
Methionine	0.011	0.280	0.270
Methionine + Cysteine	0.021	0.600	0.581
Threonine	0.061	0.650	0.596
Tryptophan	0.014	0.180	0.167

5. Vitamin and mineral recommendations

Table 6. Vitamins recommendations.

VITAMINS	Units	25 - 45 kg		45 - 75 kg		75 - End	
FAT SOLUBLE VITAMINS		Min	Max	Min	Max	Min	Max
VIT. A	i.u	6500	10000	6500	10000	5000	7500
VIT. D^3	i.u	1500	2000	1500	2000	1000	2000
VIT. E	i.u	60	100	60	100	40	75
VIT. K^3	mg	2	3	2	3	2	3
WATER SOLUBLE VITAMINS							
VIT. B_1 (Thiamine)	mg	2	3	2	3	2	3
VIT. B_2 (Riboflavin)	mg	7	10	7	10	5	8
VIT. B_3 (Nicotinic acid)	mg	20	40	20	40	20	30
VIT. B_5 (Pantothenic acid)	mg	25	45	25	45	25	45
VIT. B_6 (Pyridoxine)	mg	2	4	2	4	2	3
VIT. B_{12} (Cobalamin)	mcg	30	50	30	50	20	40
VIT. B_9 (Folic acid)	mg	1.0	1.5	1.0	1.5	0.5	1.0
VIT. B_7 (Biotin)	mg	0.05		0.05		0.05	
Choline	mg	150	300	150	300	100	200

Notes:

- Vitamin requirements are based on the latest recommendations and were derived from various sources.
- Use of minimal 50% vitamin D in the form of 25(OH)D3 or 1.25(OH)2D3 as recommended by Global Nutrition Services.
- Comply with the local legislation given per country.
- The levels can be adjusted depending on the objectives (i.e., meat quality, heat stress, etc.).

Table 7. Minerals recommendations.

MINERALS	Units	25 - 45 kg		45 - 75 kg		75 - End	
		Min	Max	Min	Max	Min	Max
Na	%	0.20	0.25	0.15	0.25	0.15	0.25
K	%		1.1		1.3		1.3
Mg	%		0.25		0.30		0.30
Fe	ppm	120		120		80	
I	ppm	1	2	1	2	1	2
Se	ppm	0.3	0.5	0.3	0.5	0.3	0.5
Cu	ppm	25		25		25	
Zn	ppm	120		120		100	
Mn	ppm	75		75		50	
Cl	%	0.15		0.15		0.15	

Notes:
- Mineral requirements are based on the latest recommendations and were derived from various sources.
- Comply with the local legislation given per country.
- The levels can be adjusted depending on the objectives (i.e., meat quality, heat stress, etc.).

6. Phosphorus

Phosphorus is one of the most important minerals in swine nutrition. It is essential for bone development, plays a key role in metabolic processes such as the formation of cellular membranes, and is vital for enzymatic systems involved in protein and carbohydrate metabolism. The ratio between calcium and phosphorus is of importance because these minerals are antagonists of each other which mean that an oversupply of calcium can negatively impact the digestibility of phosphorus.

There are two expressions used for the phosphorus calculation by nutritionists: available phosphorus and digestible phosphorus. The definition is as follows:

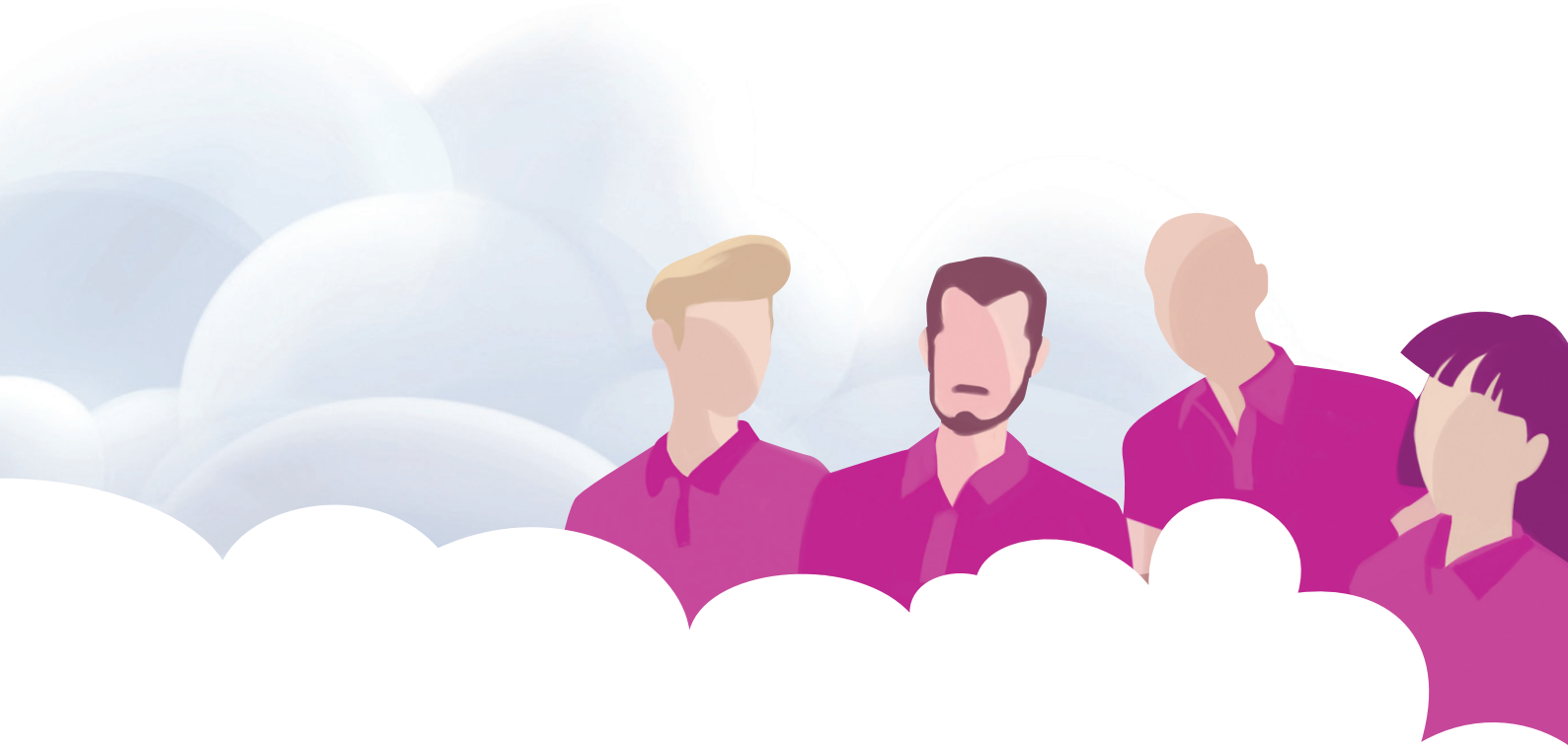
AVAILABLE PHOSPHORUS =
TOTAL PHOSPHORUS – INNOSITOL PHOSPHORUS

DIGESTIBLE PHOSPHORUS =
P INTAKE – FAECAL P / P INTAKE

In raw materials, a large amount of phosphorus is in the form of phytic acid (myo-inositol hexaphosphate). The phosphorus in phytic acid is largely unavailable to the pig. Thus, a phytase enzyme is added to diets to enhance the pig's ability to use phosphorus from phytic acid. Because manufacturers have their own individual analytical techniques, it is often confusing to compare phytase sources by a single analytical method. To avoid this confusion, Topigs Norsvin indicates the phosphorus requirements without any influences of the phytase enzymes.

The level of digestible and available phosphorus for maintenance and gain were estimated using the following equations from Bikker and Blok (2017) and NRC (2012) considering the extra gain achieved by the latest genetics.

The requirements provided by Topigs Norsvin in the appendix for calcium and digestible phosphorous were determined with the objective to unlock the genetic potential but also for bone development. The diets should always be formulated to comply with local legislation.



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