

INCREASED GENETIC GAIN IN FEED CONVERSION

DanBred recently increased its performance testing capacity by 25 % on boar testing station Bøgildgård, which means that more than 7,500 boars are now being tested for individual feed efficiency annually. This higher capacity leads to an increase in genetic gain in feed conversion ratio (FCR) by an additional 10 %.

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PROMISING STUDY ON SOCIAL PIGS

The results from this unique study pave the way for new opportunities for setting even more balanced breeding goals that can improve productivity and welfare simultaneously.

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DANBRED DUROC

Sustainable and documented breeding for more than 30 years – giving you more pork for less costs.

READ MORE ON PAGE 8



DANBRED IS READY FOR THE FUTURE

A few years into its new company structure, DanBred is finding its place in the world. A constant focus on customer needs and what will influence the market for pig production and genetics in the future guides all decision processes in DanBred. Thomas Muurmann Henriksen, CEO at DanBred, shares his thoughts on what the future holds for global pig production

Knowledge and expertise have always formed a solid foundation for us, and we are confident in the hard work our R&D

department carries out day after day, year after year. We are focused and, in many ways, our products are superior to our competitors'. However, the commercial environment is rapidly changing, so our ability to understand and meet end user needs is key to the strong growth, which we anticipate for DanBred. Here are the five key trends, we believe will influence the global pig production.

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BREEDING FOR ROBUSTNESS IN PIGS: CONFORMATION AND LONGEVITY

The breeding of robust pigs is a substantial key input factor to global pig production and ensures healthy and strong animals. Robust pigs are more resistant to changes in their environment. They stay fit and free of infections and diseases and maintain a high productivity.

To ensure robust finishers and sows, pig breeding companies have included indicator traits for robustness (such as conformation and longevity) in their breeding goals for many years.

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INCREASED GENETIC GAIN IN FEED CONVERSION

First published May 6, 2019

FEED CONVERSION: DanBred recently increased its performance testing capacity by 25 % on boar testing station Bølgildgård, which means that more than 7,500 boars are now being tested for individual feed efficiency annually. This higher capacity leads to an increase in genetic gain in feed conversion ratio (FCR) by an additional 10 %. Feed efficiency is the most economically important trait for pig producers worldwide, and DanBred has documented genetic gains for this particular trait through the decades.

At the boar testing station, future DanBred AI-boars are tested for their genetic potential for feed efficiency and all other economically important production traits. Individual feed consumption has been recorded electronically since 1992.

A few years ago, Bølgildgård was modernized, and 128 Schauer Advanced Computerized Feeding Stations replaced the first model. More than 135,000 DanBred Landrace, DanBred Yorkshire, and DanBred Duroc boars have been performance tested at Bølgildgård for individual feed consumption. The feeding stations collect data on each boar's feed intake during the testing period, and from this data a DanBred sub-index for FCR is calculated on a weekly basis. This is weighted into a DanBred index together with all the sub-indices for the other traits included in the DanBred breeding goal. Based on these indexes, the next generation of boars and gilts are selected.

An extra €0,71 per DanBred finisher pig

During the last decade, DanBred's selection for improved FCR has resulted in -0,036 kg feed/kg in genetic gain, and last year this figure decreased even more to -0,041, which equals €0,71 per DanBred finisher. This extra beneficial drop is mainly related to DanBred's implementation of 100 % genomic selection in 2017, which means that more than 105,000 DanBred purebred animals are sampled and DNA-tested annually.

"-0,036 kg feed/kg gain is a highly satisfactory genetic gain," says Helle Palmø, Chief Geneticist at DanBred. "Keep in mind that during the last decade, slaughter weight has increased at the same time by ½ - ¾ kg annually, which partly blurs the result. Feed efficiency decreases when slaughter weight increases".

Helle Palmø continues; "DanBred's breeding program is based on large breeding populations, professional nucleus breeders, and a highly advanced boar testing station. Altogether, this gives the optimal conditions for the best outcome of the breeding, and it paves the way for great results in genetic gain, where high quantity and quality data are among the key input factors".

The increase in testing capacity is due to continuous genetic gain in DanBred boars' daily gain. Due to faster growth, DanBred's boars now spend 10 days less at the test station, compared to 20 years ago. 📧



Thomas Muurmann Henriksen, CEO at DanBred, at his office in Herlev, Denmark, October 2019.

THOMAS MUURMANN HENRIKSEN: DANBRED IS READY FOR THE FUTURE

First published, October 22, 2019

KEY TRENDS: A few years into its new company structure, DanBred is finding its place in the world. A constant focus on customer needs and what will influence the market for pig production and genetics in the future guides all decision processes in DanBred. Thomas Muurmann Henriksen, CEO at DanBred, shares his thoughts on what the future holds for global pig production.

Knowledge and expertise have always formed a solid foundation for us, and we are confident in the hard work our R&D department carries out day after day, year after year. We are focused and, in many ways, our products are superior to our competitors'. However, the commercial environment is rapidly changing, so our ability to understand and meet end user needs is key to the strong growth, which we anticipate for DanBred. Here are the five key trends, we believe will influence the global pig production.

- Knowledge and expertise have always formed a solid foundation for us, and we are confident in the hard work our R&D department carries out day after day, year after year.

Thomas Muurmann Henriksen

1: Growing global demand for pork

An important trend is that the global demand for pork is expected to grow by up to 45 % by 2035. This is due to a growing population; especially a growing middle class and increased buying power in the Asian and American markets. The growing global demand represents great growth potential, and as a supplier of breeding animals to more than 40 countries, DanBred is well-positioned to tap into that potential.

We have already established DanBred in key markets such as Spain, France, and the Netherlands, and are well under way in e.g. Russia, Mexico, the Philippines and the US.

The subsidiaries will be supported by strong resources in Denmark; our genetic improvement derived from our nucleus and

multiplier herds and our R&D engine, Danish Pig Research Centre.

- High-quality genetics form the foundation of our business. Now we also offer a range of service solutions, which help our customers tap into the full potential of our products.

Thomas Muurmann Henriksen

2: From supplier to business partner

Pig producers are getting bigger, more professional and have more complex buying criteria. This puts high demands on us. It is no longer enough to be a supplier of genetics or sows. We are, increasingly, becoming a business partner delivering solutions, which ensure that the animals' genetic potential is fully realised. It is a trend we have seen in several other trades, where service solution sales have even exceeded the sale of core products.

In DanBred, we welcome this development, because it goes well with our open and pragmatic culture of cooperation



as well as our expertise and product portfolio. High-quality genetics form the foundation of our business. Now we also offer a range of service solutions, which help our customers tap into the full potential of our products. This allows us to build close and lasting relations to our customers.

We also anticipate that more pig producers will have investors who want performance-based business models, where they pay for the production results that our products deliver. In this regard, DanBred has a clear competitive advantage due to the great potential of our products. For the past decades, we have bred for both large litter size, low mortality and low feed consumption – and, therefore, our customers currently achieve up to 40 live piglets per sow / per year.

3: Closed herd production gains ground

A third trend is that a growing number of pig producers around the world are shifting from open herd production to closed herd production as a consequence of the growing focus on health in pig production – and that development is expected to pick up speed as diseases like African Swine Fever (ASF) are, sadly, ravaging large parts of Asia and Eastern Europe.

In DanBred, we have many years of experience delivering genetics for closed herd productions, not least in Denmark, where this encompasses the majority of pig producers, and this know-how is scalable in relation to customers outside Denmark as well. We offer our customers unlimited and direct access to DanBred's breeding system

through GenePro, which ensures genetic progress while maintaining the health status of the herd.

- We are at the forefront of this development, as we have had balanced breeding goals for decades focusing on high efficiency, longevity and survival rates, which, among other benefits, contributes positively to the climate footprint of pig production and, thus, sustainability.

Thomas Muurmann Henriksen

4: Sustainability becomes license to operate

Sustainability is high on the agenda – and it is here to stay. We are at the forefront of this development, as we have had balanced breeding goals for decades focusing on high efficiency, longevity and survival rates, which, among other benefits, contributes positively to the climate footprint of pig production and, thus, sustainability.

Our R&D activities have generated breeding progress and resulted in genetics, which have reduced the feed consumption in DanBred animals and ensure that every sow produces as many live piglets as possible. Furthermore, we breed for robustness. This results in healthy, strong and durable animals, which in turn improves animal welfare and optimizes our customers' earnings. Furthermore, as a supplier of genetics for more than 40 countries, we enable pork to be produced locally, close to where it is consumed.

- An important element in the race for leadership will be R&D. Genomic selection and other technological tools and methods are gaining ground, and only the large and most professional genetics companies have the R&D muscles, which will be required in the future.

Thomas Muurmann Henriksen

5: Industry consolidation

We anticipate a consolidation in the pig genetics industry, as the customers become bigger, more professional and more advanced. There will be fewer players, and it will happen soon. There will only be room for the players who deliver products with the highest efficiency and health. Our objective is to be among the top 3 global pig genetics brands well-positioned for the long run.

An important element in the race for leadership will be R&D. Genomic selection and other technological tools and methods are gaining ground, and only the large and most professional genetics companies have the R&D muscles, which will be required in the future.

DanBred is already among the leaders. We have a strong R&D engine in DPRC, which ensures continuous and record-breaking breeding progress. Our R&D is deeply rooted in one of the most developed and demanding markets, and the best suppliers and customers in the world are right outside our door.

We are ready for the future. ☞



DANBRED LAUNCHES MANUAL FOR HANDLING ON-FARM BOARS

First published May 29, 2019

MANUALS: Building on the success of the Sow & Gilt Manual launched in the autumn of 2018, DanBred now releases a new comprehensive boar handling manual. This is part of DanBred's increasing commitment to knowledge sharing and working together with leading pig producers for profitable growth.

Trine Lund Pedersen, Head of Technical Services at DanBred, says: "DanBred Boars are high quality, performance tested animals. The management and facilities should match the quality of the boars to release their full genetic potential. We now want anybody who has an in-house AI facility, to access all the necessary tools to build the foundation for giving their DanBred boars a long and productive life."

DanBred aims to bring their technical knowledge and know-how to anyone, who can use it to make a practical difference in their pig production, no matter where they are in the world.

Trine Lund Pedersen continues: "DanBred is built on transparency and a continuous dedication to creating a profitable business for our customers. The manuals bring that transparency and dedication to releasing the full genetic potential of our core product into the 21st century, and my team and I are massively proud of being a part of that movement".

The manuals can be found online at www.danbred-manual.com, and you can also download the DanBred app for Android and IOS (search for DanBred in the app store). ☞

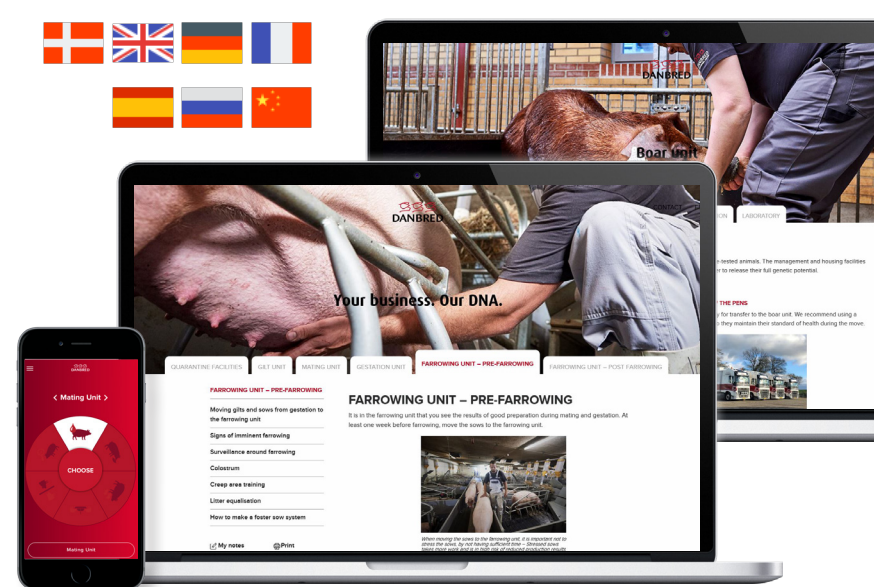


Your business. Our DNA.

DanBred Manuals Succeed with our DNA!

The DanBred system gives you access to some of the best reproductive animals in the world, and now you can also benefit from our unique knowledge of working in the pigpen. We have concentrated many years of experience into the DanBred Manuals in order for you to get the optimum yield from the genetic potential of your DanBred animals.

The Manuals are with you all the way, and they detail precisely how to handle DanBred breeding animals through the most important phases of their lives. The content is based on best practice experiences and is supplemented with images and illustrations, and since DanBred genes are used extensively all over the world, the Manuals are also available in several languages. We hope that you will use the Manuals actively and share them with your colleagues. Both the new and young as well as those who have many years of experience.



DOWNLOAD THE DANBRED APP



YOU CAN FIND ALL MANUALS AT

danbred-manual.com





WHY SOCIAL PIGS ARE A GAIN FOR DANBRED CUSTOMERS

First published June 6, 2019

STUDY: The results from this unique study pave the way for new opportunities for setting even more balanced breeding goals that can improve productivity and welfare simultaneously. In the future, this means the inclusion of a new social trait in the DanBred breeding goal, which will improve genetic gain in daily gain by an additional 5 -10 %. Furthermore, this may also contribute to improved animal welfare – simply because a sweet and social pig is supporting its pen mates in a positive manner. At this very moment, Danbred has completed a large-scale selection experiment focused on “breeding for social pigs” and its effect on reducing excessive aggression, mounting behaviour and tail-biting. The final results are expected at the end of 2019.

Improving productivity and welfare through breeding for social pigs

A pioneering study by the Danish Pig Research Centre confirms pig sociability as a relevant trait in the breeding goal. This new trait will add to the genetic progress and further to the daily gain and keep DanBred on the cutting edge of pigs' genetics.

Positive social behaviours among pigs enhance the growth of pen mates and this tendency is passed down from generation to generation. In other words, it is heritable. A unique study performed by the Danish Pig Research Centre (DPRC) indicated how DanBred's pigs, with a positive social genetic profile (social pigs), have a positive effect on the daily gain of their pen mates. When accounting for both the direct effect of the pig's own genes and as well as the social

genetic effect of others, the genetic gain in growth is potentially increased by 5 -10 %. This knowledge can be used to increase genetic gain for daily growth and improve the social behaviour and welfare of DanBred pigs. This was concluded as part of a large research project on DanBred Landrace pigs between DPRC and Aarhus University.

The study

The current study included the average daily gain (ADG) from 30 to 94 kg recorded on a total of 32.212 male and 48.252 female DanBred Landrace pigs. The pigs were raised in 13 DanBred nucleus herds in sex separated pens with between 8 and 15 pigs per pen.

During the study the genetic variation and heritability for direct genetic effects (the effect of a pig's genes on its own growth) and for indirect genetic effects (the effects of a pig's genes on the growth of its pen mates) were estimated. The results showed a significant genetic variance for indirect genetic effects for ADG in both male and female pigs, which indicates that it is possible to select pigs for sociability in relation to growth.

The heritability for the pig's own genetic potential was 22 % and 24 % for female pigs, whereas the estimated total heritability (the direct and the indirect genetic potential combined) were 32 % for male pigs and 27 % for female pigs. This means that heritability increased by 45 % in male and 13 % in female pigs when accounting for the genetic background of social interactions, and that there is in fact an unused selection

potential for growth. This potential can be used to make further genetic progress for ADG in DanBreds' populations.

- The results from this unique study pave the way for new opportunities for setting even more balanced breeding goals that can improve productivity and welfare simultaneously. In the future, this means the inclusion of a new social trait in the DanBred breeding goal, which will improve genetic gain in daily gain by an additional 5 -10 %.

Helle Palmø, Chief Geneticist, Ph.D., DanBred

Predicting the social potential

In order to be able to conclude that genetic selection on social traits will result in genetic progress, it is necessary to account for all genetic variance. To overcome this very complex issue, DPRC also tested whether it would be possible to predict the genetic potential for social interactions purely based on the information from relatives. Unlike previous studies, this study shows very clearly that it is possible. In fact, the results showed that the so-called predictive ability for growth was improved by approximately 7 % when accounting for the genetic potential for social interactions on top of the genetic potential for the pig's own growth. Predictive ability is an analogue to accuracy of selection, which is an indicator of how much additional genetic gain can be achieved for the benefit of DanBred's customers.

Because previous studies have found gender differences in behaviour, this current study also hypothesized that test

results may differ between male and female finishers. It is expected that male pigs show more aggressive behaviour than female pigs. However, the issue is more complex. In the current study, the results show that there is competition between female pigs, but none between male pigs. Senior scientist Birgitte Ask from DPRC explains:

“This study shows that female DanBred Landrace pigs, which have a high genetic potential for their own growth, tend to inhibit the growth of their pen mates, whereas this is not the case in male DanBred Landrace pigs. In practice, this means that if the genetic potential for social interactions is unaccounted for, then the realized growth of female pigs will be lower than expected based on their genetic potential for their own growth. This information is very important to maximise the genetic gain for growth, not least when estimating the genetic potential for growth in selection candidates in nucleus herds”.

When accounting for the above-mentioned differences between male and female pigs regarding genetic potential for social interaction, the predictive ability for male and female growth is improved by approximately 15 % and 4 % respectively. Altogether, this implies that accounting for gender differences can give an additional increase in genetic gain for growth. In particular as selection intensities are higher in males than females, improving the accuracy with which the genetic potential for growth of male selection candidates can be predicted has a larger

impact on the selection response than an equivalent improvement in the accuracy for female selection candidates.

- If the genetic potential for social interactions is unaccounted for, then the realized growth of female pigs will be lower than expected based on their genetic potential for their own growth. This information is very important to maximise the genetic gain for growth, not least when estimating the genetic potential for growth in selection candidates in nucleus herds.

Birgitte Ask, Senior scientist, DPRC

Improving own and pen mates' growth

By considering the social genetic potential for growth in a breeding program, it will be possible to improve not only the pig's own genetic potential for growth, but also the pig's genetic potential to stimulate the growth of its own pen mates. It is the hypothesis and goal that such an improvement will also lead to favourably correlated responses in damaging behaviours of group housed pigs.

To test this hypothesis, DPRC recently completed another large-scale selection experiment with recordings of tail and ear biting injuries and skin lesions from fighting on approximately 4.500 crossbred offspring in 270 groups. Results from this experiment are expected by the end of 2019. ☒



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NEWSLETTER: We regularly publish a newsletter and you can subscribe on our website. Here you can get a quick overview of the latest news from DanBred's media section, which contains a mix of news articles, press releases and professional knowledge sharing.

You can unsubscribe from our newsletter at any time and we never publish the newsletter more than twice a month. We only publish material when we believe we have something to share. To subscribe to our newsletter, go to www.danbred.com

The new DanBred Knowledge Hub

DanBred genetics is your access to world class reproductivity and efficiency, and we always want to make sure that you achieve all the benefits of your DanBred breeding stock.

So to help you release the full genetic potential, we now give full access to our library of knowledge, best practice articles, informative videos, step-by-step guides and comprehensive Manuals in our brand new Knowledge Hub.

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DANBRED DUROC: MORE PORK FOR LESS COSTS

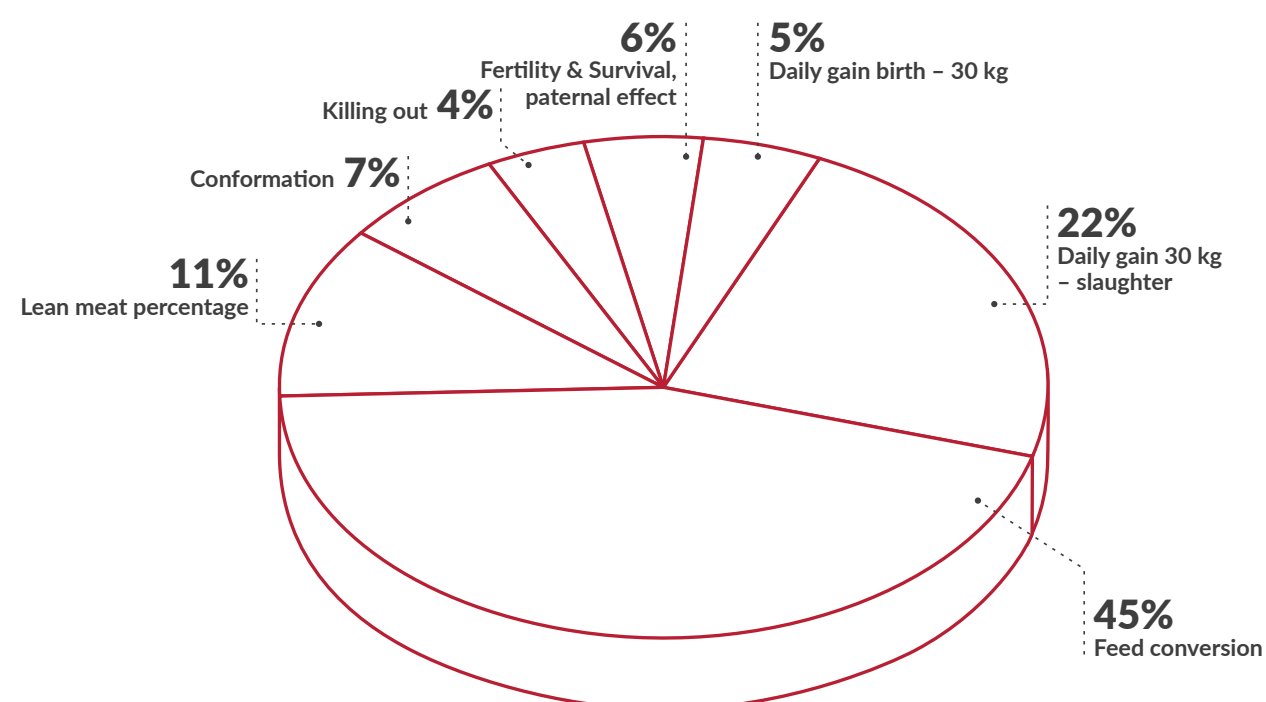
First published September 5, 2019

BREED: DanBred Duroc makes your business highly competitive, giving you more pork for less costs.

DanBred Duroc is used as the terminal sire in the DanBred cross-breeding program, where the performance is excellent in combination with the DanBred Hybrid. DanBred Duroc produces large litters as well as fast growing finisher pigs with low feed conversion ratio and a high lean meat percentage. As an extra benefit DanBred Duroc produces carcasses with an excellent meat quality.

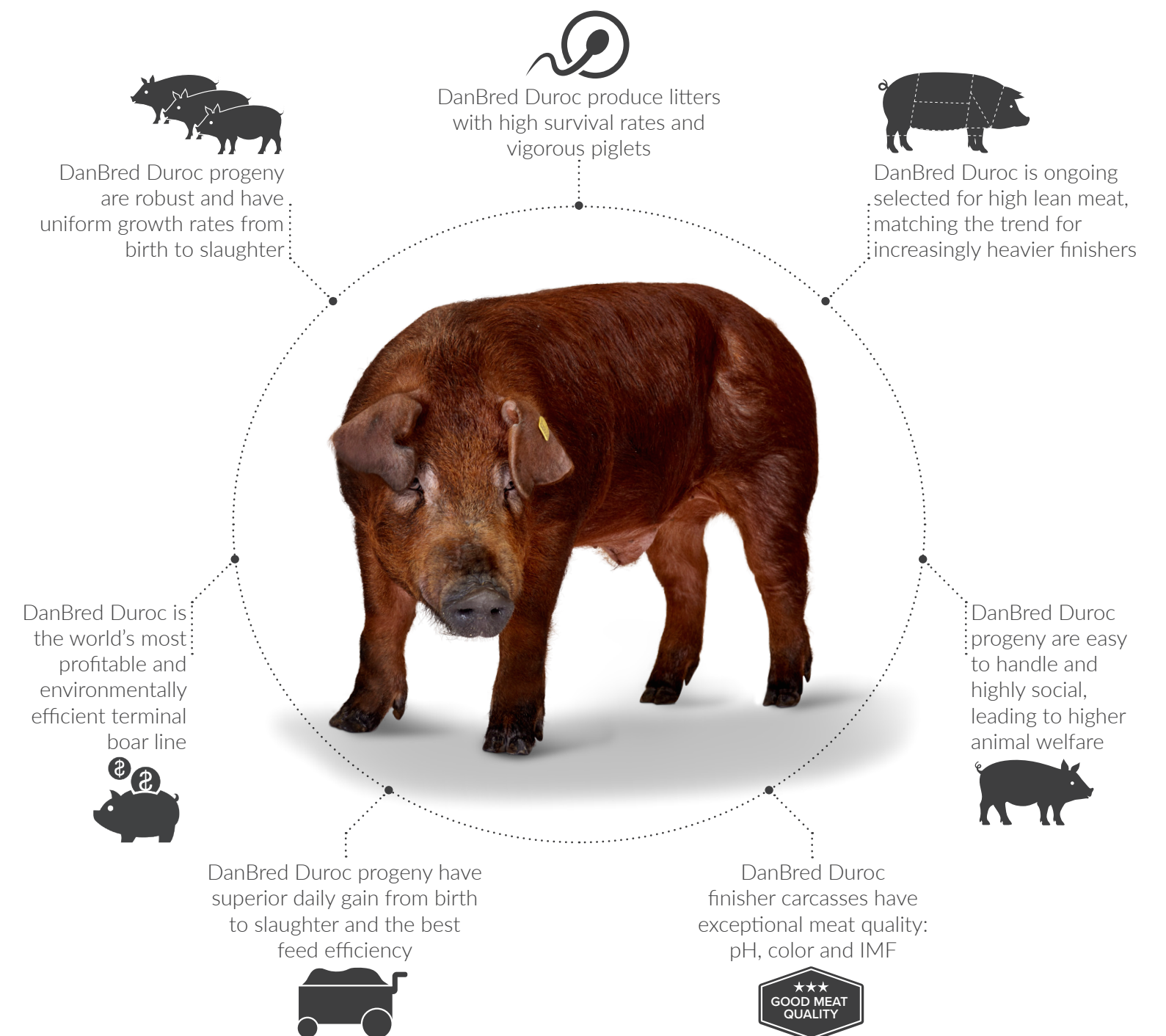
DanBred Duroc originates from North America; the race was imported to Denmark in the 1970s. Through decades of professional selection, the breed has been genetically improved particularly in regard to meat percentage and slaughter loss.

When using Danbred Duroc as the terminal sire, our customers not only gets more pork for less costs but in addition high class pork quality that is in high demand around the World. Efficient genetics, like DanBred Duroc is not only profitable for the producer, but also makes major contribution to reducing carbon footprint from pork production. 🌱



**DanBred Duroc
2018 - present**

Your business. Our DNA.



Average performance results

In total around 100.000 DanBred breeding animals are performance tested.

	Average production for boar testing station Bøgdgård	Average production results achieved by DanBred boars in Nucleus herds	Average production results achieved by DanBred (gilts) females in Nucleus herds
Daily gain, g/day 30 kg - slaughter	1241	1236	1166
Daily gain, g/day Birth - 30 kg	-	413	416
FU/kg gain 30 kg - slaughter	2.06	-	-
Killing out percentage	24.85	-	-
Lean meat percentage	62.0	61.7	61.9
Scanning measurement, mm	6.5	6.9	6.7
Scanning weight, kg	95.9	96.5	95.7

Sources:
SEGES Publication No 1154 (2018),
ANIMAL SCIENCE ML M Pedersen et al (2019)
SEGES Publication No 1075 (2016)
SEGES Publication No 1154 (2018) & No 1093 (2016)
AGRICULTURAL AND FOOD SCIENCE A. Rybarczyk et al. (2018)

DanBred Duroc D(LY) progeny are:

- stronger and more robust
- born in bigger litters due to high male fertility

DanBred D(LY) finishers have excellent performance results (30-100 kg) as evidenced by:

- world class growth rates 1079-1093 g daily gain
- superior feed conversion ratio 2,31 FEs/kg
- eminent lean meat percentage 61,8 %

DanBred D(LY) finishers have superior meat quality (90 kg) as evidenced by:

- high content of intramuscular fat: 2,57 %
- high sensory evaluation of juiciness, tenderness and flavor
- high level of pH 24-96 h post mortem: 5,72

Bonus information:

Research indicates that since the RN and Halothane genes have been removed from the DanBred breeds decades ago, pH no longer influences production yield, which is why pH is no longer part of the DanBred breeding goals.

DANBRED ESTABLISHES SUBSIDIARY IN SPAIN

First published December 18, 2019

SUBSIDIARY: Since the new DanBred was established at the end of 2017, the company has rolled out a strong subsidiary- and agent structure throughout Europe. Now the structure for Spain is revealed with the establishment of a subsidiary company.

The new set-up will ensure the continuous supply of DanBred breeding animals and genetics to the Spanish market, as well as a clear DanBred identity and profile in the country.

Thomas Muurmann Henriksen, CEO of DanBred, says: "Spain is a key market for us. DanBred currently supplies approximately 25 % of the Spanish market, and we expect to make that share even bigger with this new subsidiary set-up. We see massive potential in Spain".

The establishment of a Spanish subsidiary has come to pass in collaboration with long established DanBred agent Xavi Villarroya, who becomes CEO in Spain.

- Spain is a key market for us. DanBred currently supplies approximately 25 % of the Spanish market, and we expect to make that share even bigger with this new subsidiary set-up. We see massive potential in Spain.

Thomas Muurmann Henriksen, CEO, DanBred

In a market characterized by large integrators, who have high expectations to both the core genetic product as well as the service solutions offered around the product delivery, continuity and a solid

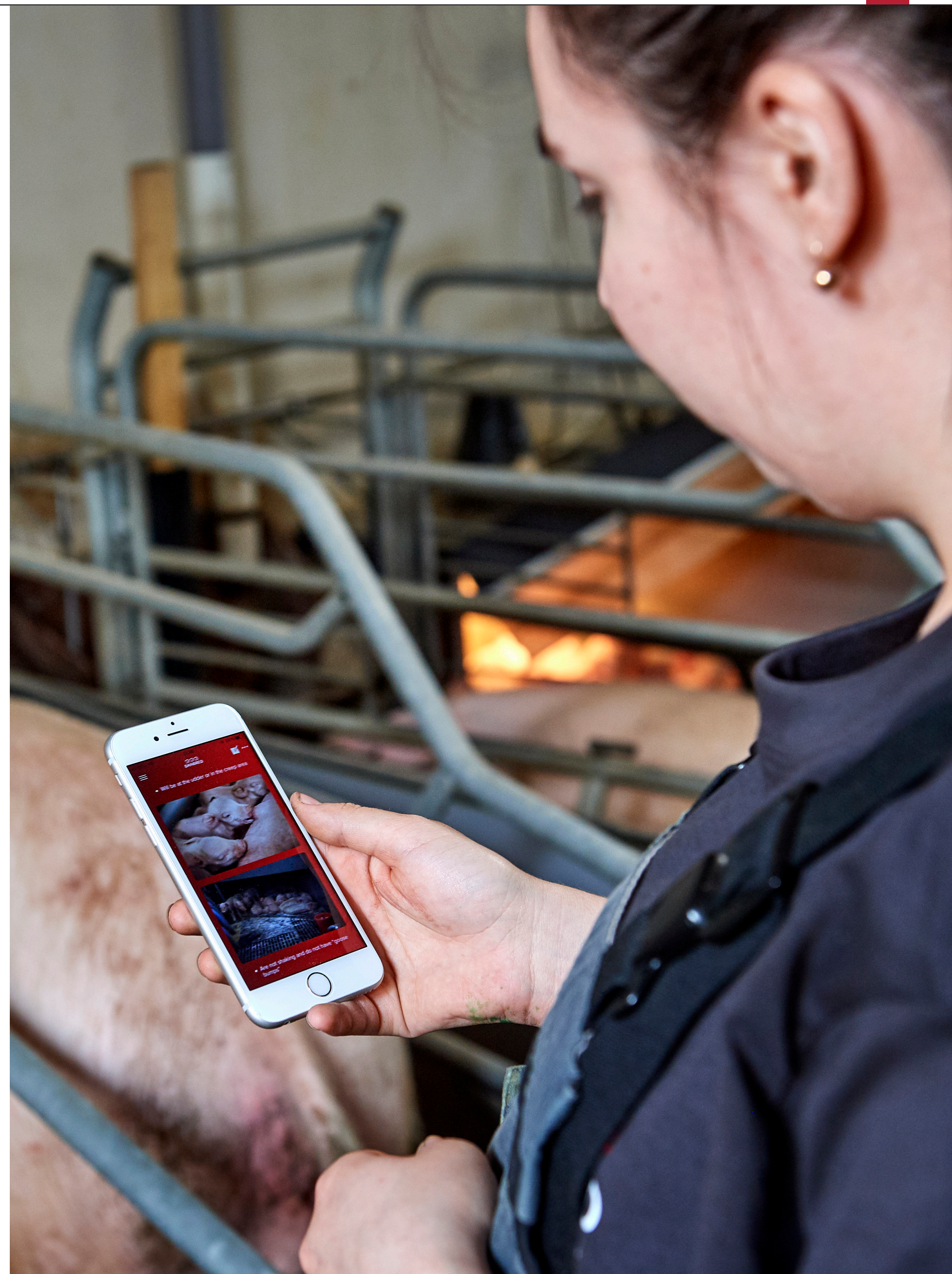
understanding of how the market works, is key.

Xavi Villarroya and his team are a vital part of our new structure. Our Spanish customers are in safe hands with a team that knows the market inside out, and we are delighted that Xavi and his team now officially becomes part of the DanBred-family, Thomas Muurmann Henriksen says.

DanBred's activities in Spain include sale of breeding animals, primarily from breeders and multipliers in Denmark, as well as a substantial number of customers with their own On Farm Replacement Agreements (GenePro agreements). There are also several A.I stations with DanBred boars. 🐷



Your business. Our DNA.



DANBRED GLOBAL OFFICES GET IN TOUCH WITH US TODAY





DANBRED TRIUMPHS AT AWARD SHOW IN SPAIN

First published January 7, 2019

AWARDS: *DanBred's Spanish customers have good reasons to be excited these days. At the recent Porc d'Or awards ceremony, which is an award that celebrates Spanish pig and livestock producers, 33 out of 49 awards were given to Spanish pig producers using DanBred genetics and breeding animals.*

Since 1994, the Spanish research center Institute of Food Research and Technology (IRTA) has celebrated the best results and progress in pig production with the Porc d'Or award. The award has different sub categories and ranks the pig producers by their sizes, and this year turned out to be a huge triumph for many DanBred customers using DanBred genetics and DanBred breeding animals.

33 out of a total 49 awards ended up being handed out to DanBred customers in different categories making it a memorable night. The local DanBred sales team in Spain consists of agents and is fronted by Xavier Villarroya, and he could not be

happier for the costumers.

I am very pleased and happy that the Spanish pig producers have received such an important recognition from an esteemed organization as IRTA. It's a very big pat on the shoulder for our customers, says Xavier Villarroya.

25 golden years

Spain is one of the biggest markets in Europe, and according to the Danish Agriculture & Food Council, Spain slaughtered 50 million slaughter pigs in 2017, which is only surpassed by Germany's 58 million slaughter pigs. In other words, Spain is a key market for DanBred and Thomas Hansen, Sales Director for DanBred, is happy about the results in Spain at the Porc d'Or awards.

We're very proud but also humbled by the fact that we have the opportunity to supply the best and most efficient Spanish pig producers. We're thrilled on their behalf, and at the same time it underlines that DanBred is the preferred choice for

some of the most skilled pig producers in the world, says Thomas Hansen.

Spanish pig production has gone through an explosive development in the past 25 years. In 1994, the "weaned pigs pr. sow pr. year" was 19.7, and in 2017 it had climbed to 29.46. In the same period, the farrowing percentage increased from 79.63 % to 87.36 %, and the numbers illustrates the transition of the Spanish market during the last couple of decades. ✂

Facts:

- The Institute of Food Research and Technology (IRTA) is responsible for the Porc d'Or.
- The award started in 1994 and this year the venue was in Lleida, Spain.
- 800 production sites and 950,000 breeders supply IRTA (BDporc - Bench of Reference Data of the Spanish pig) with data and statistics, which is the foundation of the award.
- This year, the award had 49 categories and +120 nominees.

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UPDATES: Do as 6,000 other pig enthusiasts from around the globe and follow DanBred on social media.

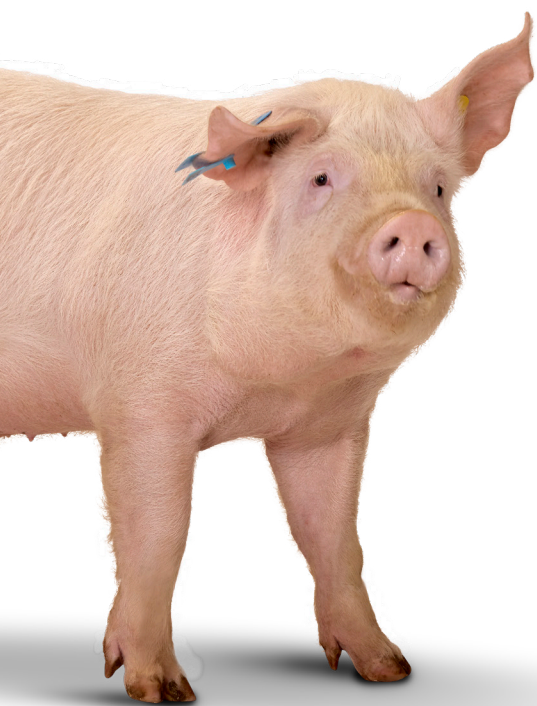
Here you will find a mix of links to our technical and professional articles, stories and tips from both Danish and foreign farms as well as glimpses of everyday life in DanBred; our office life, our suppliers, and our customers.

DanBred is on an exciting journey, and the easiest way to stay updated is on our social media platforms, where we keep our followers up to date on a weekly basis.

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Find us on Youtube:
www.youtube.com/danbred



BREEDING FOR ROBUSTNESS IN PIGS: CONFORMATION

First published July 4, 2019

CONFORMATION: This is the first of two articles on breeding for robustness in pigs and focuses on conformation.

The breeding of robust pigs is a substantial key input factor to global pig production and ensures healthy and strong animals. Robust pigs are more resistant to changes in their environment. They stay fit and free of infections and diseases and maintain a high productivity.

This improves the financial position of pig producers and improves animal welfare in pig production. To ensure robust finishers and sows, pig breeding companies have included indicator traits for robustness (such as conformation and longevity) in their breeding goals for many years.

However, as productivity increases, so does the importance of robustness and balanced breeding goals. A balanced breeding goal will not only focus on increasing productivity, but also ensure genetic gain in health and survival to improve the robustness of the pigs.

Robustness covers a variety of traits

Robustness covers a variety of traits including both productivity and health-related traits in relation to challenging environments or simply changes in the environment. Such challenging environments might include suboptimal nutrition, high pathogen loads, temperatures that are too high or too low, or insufficient ventilation.

Robustness reflects the ability to adapt to any of these. Some breeding companies will define robustness as production efficiency, for example feed conversion, growth, meat percentage, or fertility in a challenging environment. Others also define it as resistance or tolerance to diseases and injuries, as well as reduced culling and mortality losses. However, these latter traits can be challenging to improve through genetic selection because they are difficult or costly to record, of low frequency –

particularly in nucleus herds – and have low genetic variability and heritability.

Breeding companies, therefore, attempt to identify indicator traits that can be more easily measured in nucleus herds and have a higher level of genetic variability and heritability.

Conformation is an indicator for robustness

One such indicator trait for robustness is conformation, which reflects the strength and health of a pig's legs, hooves, and back, and includes anatomical anomalies that can be either innate or due to, for example, suboptimal nutrition, housing or infections.

Selection for improved robustness through conformation is expected to increase productivity and welfare, as well as to benefit the production period of finishers and production sows through a reduced risk of culling. Conformation problems can cause lameness, increase the risk of finisher culling, and are typically reported as the reason for 10-15 % of sow culling. Moreover, lameness is known to involve pain and stress for the pig and to reduce productivity.

In finishers, lameness is related to reduced feed intake and growth, and in production sows, lameness is negatively correlated to the sow's reproductive ability. Conformation is, therefore, an obvious indicator trait to achieve genetic gain in robustness.

Selection for conformation

Robustness of pigs is an important part of DanBred's breeding program and has been for many years. Both conformation and longevity have been included in the breeding goals for all three breeds in the breeding program: DanBred Landrace, DanBred Yorkshire, and DanBred Duroc. In fact, DanBred has carried out selection for conformation since 1995.

Phenotypic records on conformation are collected by expert technicians, who allocate

Fig. 1 & 2. Blow correct position of front and hind legs, an example of good conformation score in front and hind legs.

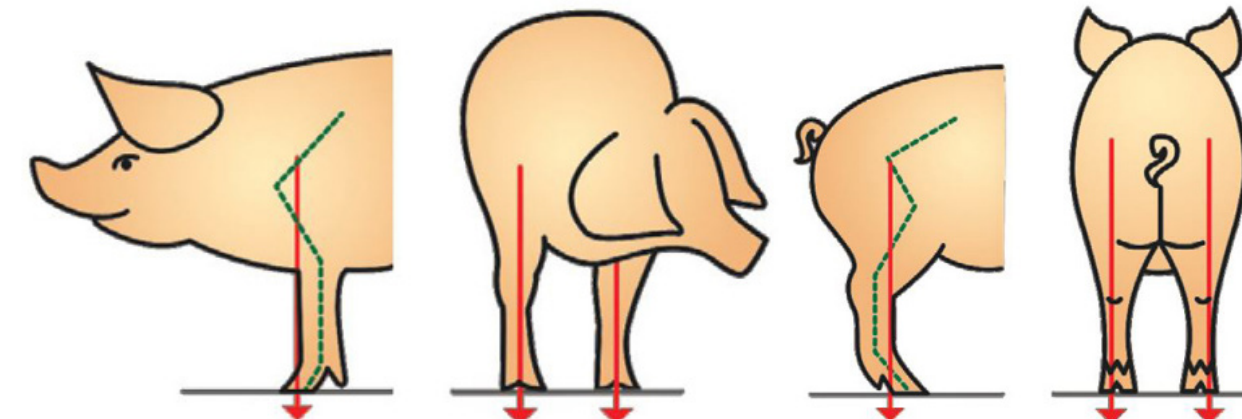


Fig. 3. The cumulative phenotypic gain of daily gain (30-100kg) from 2009-2018 in DanBred Landrace and DanBred Yorkshire, respectively.

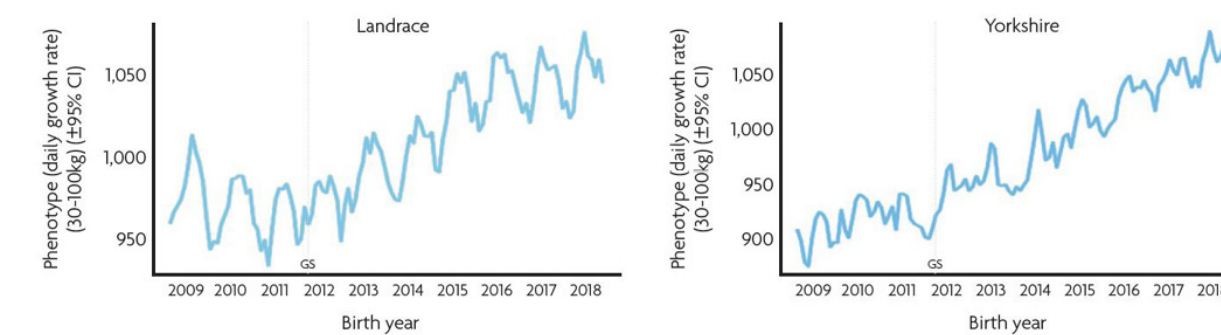


Fig. 4. The cumulative phenotypic gain of meat percentage from 2009-2018 in DanBred Landrace and DanBred Yorkshire, respectively.

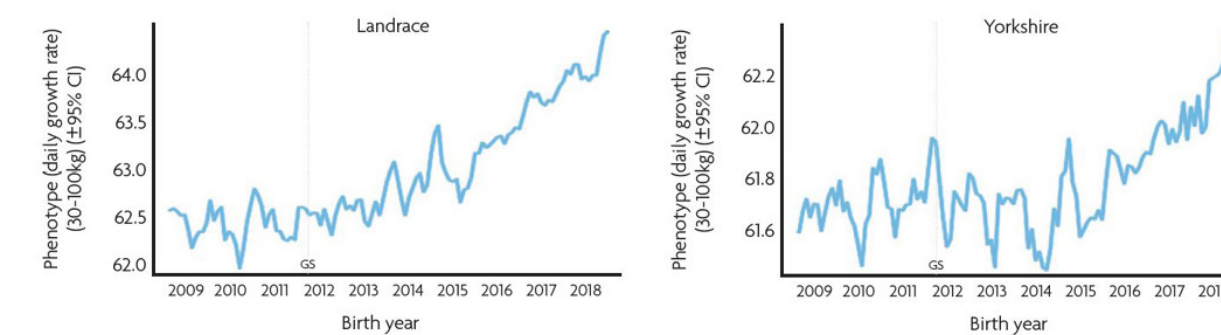
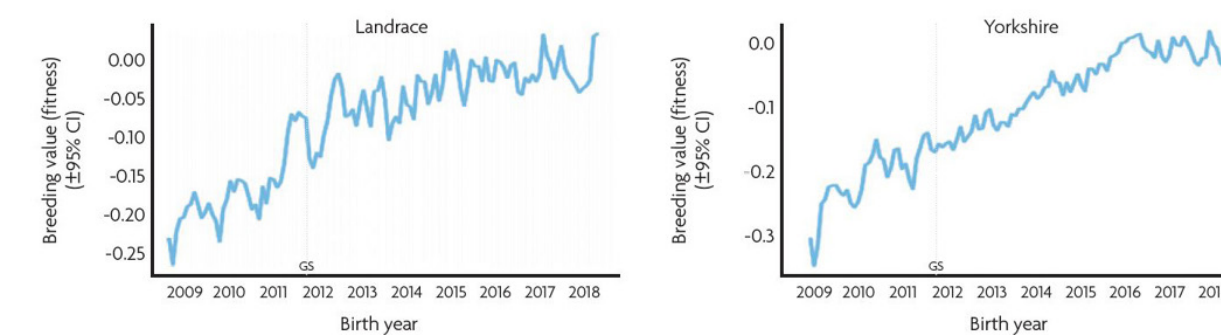


Fig. 5. The genetic gain of conformation from 2008-2018 in DanBred Landrace and DanBred Yorkshire, respectively.



a subjective conformation score to each pig. The score is based on an evaluation of the pig's front and hind legs as well as its back and general carriage.

The pig's conformation is assessed while the animal is moving, because limping and lameness are not always visible in an immobile pig. To obtain an accurate and objective evaluation of conformation with the highest possible genetic variation and heritability, it is important to have an optimal environment while scoring.

Such an environment would include an anti-slip floor, and optimal light and space conditions to enable a full view of the pig and its movements – not only from the back but also from the front and side. Moreover, the pigs must be accustomed to human handling, otherwise they will be stressed during the evaluation, which could cause a different movement pattern. Lastly, proper training of the technicians is important to maximise objectivity as well as intra- and interobserver repeatability.

Examples of undesirable conformation characteristics include inwardly or outwardly curved front legs or swayback. Examples of desirable conformation characteristics are a smooth back line and no problems observed on the legs or hooves (Figs. 1 and 2). In total, ~100,000 pigs from 23 breeding herds are performance tested each year and receive phenotypic records on conformation.

Balanced genetic progress

Selection for improved conformation has contributed to a robust DanBred pig that grows 150-200 g/day faster and has a meat percentage that is 1.52.5 percentage points higher than 10 years ago (Figs. 3-5). With such considerable genetic progress for productivity, simultaneous selection for health- and survival-related traits, such as conformation has been paramount to ensuring healthy and robust pigs. It is an important reason why DanBred have never experienced any serious health issues in its breeding stock.

Genetics of conformation

Conformation is a low to moderately heritable trait, with estimated heritability in studies on Landrace and Yorkshire pigs



typically varying between 0.04 and 0.15. The heritability will vary not only due to differences in breed, but also due to differences in the environment in which it is recorded, the environment in which the pigs have been raised, and the expertise of technicians.

In recent years, the heritability of conformation in DanBred Landrace, DanBred Yorkshire, and DanBred Duroc respectively have been 0.19, 0.15, and 0.20. The heritability determines the potential for genetic progress for conformation, but to achieve progress in robustness, favourable genetic correlations to other robustness traits are required.

A study from 2015 on DanBred pigs showed that the conformation score had a favourable genetic correlation to the number of live-born piglets of up to 0.36,

as well as a favourable genetic correlation to the weaning-to-service interval in second parity of -0.35. This means that pigs with a higher (good) conformation score tend to give birth to more live piglets and come more quickly into heat after weaning than pigs with a lower (bad) conformation score.

Maximising future progress

DanBred has developed a new method to evaluate the conformation of pigs in the performance test in the breeding program. This new method has been proven to ensure improved utilisation of the conformation recordings to determine genetic differences in robustness among the candidates. The new method involves a new definition of the conformation trait, which makes it easier to differentiate between the best pigs, thereby allowing for

more accurate selection of the strongest pigs as parents for the next generations.

The new trait definition includes more categories on both front and hind legs, back, and general carriage, and has a higher genetic variance and heritability compared to the previous conformation definition. With the new method, the heritability and predictive ability are improved by 10 % compared to the previous conformation definition. The heritability for conformation, i.e. the differences between pigs that are caused by genes and not environment, is now as high as 22 %. The new method will be implemented during the summer of 2019 and it is expected to result in increased genetic progress for conformation by up to 5 %.



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DanBred has more than 75 skilled nucleus and multiplier herds all over Denmark, which produce breeding stock with a high health status and world-class genetic potential.

Their daily work is vital to the development of the DanBred breeding programme, and it enables DanBred to be able to support pig producers across the globe in optimizing their businesses, increase their profits and create success stories in their own herds.





BREEDING FOR ROBUSTNESS IN PIGS: LONGEVITY

First published October 22, 2019

LONGEVITY: This is the second of two articles on breeding for robustness in pigs. This article focuses on sow longevity.

Robust pigs are healthier, stronger, more resistant to changes in their environment and maintain a high productivity. Therefore, pig breeding companies include indicator traits for robustness – such as conformation and longevity – in their breeding goals.

Longevity – an indicator for robustness

Sow longevity (Longevity) is an indicator trait for robustness. Longevity is generally defined as the length of productive life of a sow. In pig production, this most often reflects the sow's ability to avoid being culled and, thereby, its ability to keep reproducing piglets.

The environment affects longevity

Longevity is affected by the environment in which the sows live. A vital factor is the strategy used by the farmer to cull the sows. The culling strategy is influenced by herd-specific procedures, except in cases where animal welfare or biosecurity guidelines necessitate involuntary culling. These guidelines describe when sows should be culled. However, the farmer's own opinion of what constitutes a good production sow will also influence the culling decision. The differences in culling strategies between herds make it difficult to identify what is required for a sow to achieve high longevity. In general, the reproductive ability of a sow is influenced by different factors relating to both voluntary and involuntary culling.

Longevity is, however, an important aspect of maintaining highly efficient

and healthy sows in the pig production industry. Moreover, a robust sow with a long reproductive life must be considered a more sustainable sow, than a sow with a shorter reproductive life. Because she reproduces more litters in her lifetime, which means the farmer can produce the same amount of litters with less sows.

Genetic progress is possible

As longevity is partly genetically determined, it is possible to attain genetic progress. However, to achieve potential genetic gain for longevity, it is important to consider genetic correlations to other traits before including the trait in a breeding index. Studies from 2007 and 2014 showed that longevity-related traits had a favorable genetic correlation with conformation scores in young sows. This means that a strong and healthy sow is more likely to come into heat after weaning its first litter.

The trait conformation alone does not cover all the information for a robust animal, whereas the trait longevity includes information on the sow's reproductive lifetime. Therefore, selecting for both longevity and conformation will increase the level of robustness among production sows.

Just as conformation, longevity has an unfavorable genetic correlation with common production traits (average daily gain, lean meat percentage and backfat thickness). This highlights the importance of including robustness traits such as longevity and conformation in the pig breeding goal – where demands for high productivity are increasing – to ensure a sustainable and balanced breeding goal.

Selection for longevity

Longevity is not easy to select for: Phenotypes are recorded at culling, and a culled sow cannot be used for breeding. It can, therefore, take several generations to collect enough longevity data. In pig breeding, we select the best animals among the young boars and gilts. Therefore, it is necessary to gather information on longevity from the young animals' dams, grandmothers, and aunts. Information on longevity is distantly related between the young gilts and boars selected for longevity and the offspring for the next generation, whose breeding values we wish to know. This makes it very difficult to calculate useful breeding values for longevity. This also leads to a reduction in genetic gain, as the accuracy of breeding value estimation from relatives is proportional to the degree of relatedness.

Another challenge is the interaction between the production environment and longevity, which makes longevity more difficult to select for. The culling strategy in multiplier herds often relies on breeding values, as they aim to provide their customers with the best possible sows. This is reflected in the number of litters

Measuring longevity

Longevity can be measured as either the number of days from birth to culling, or the number of days from first farrowing to culling. But it can also be measured as the number of litters produced or total production of piglets.

Genetics of longevity

Longevity is a low-to-moderately heritable trait. Estimated heritability in studies on Landrace and Yorkshire pigs typically vary between 0.08 to 0.17. The variation in heritability is not only due to breed differences, but also due to data quality and differences in the environments in which the trait is recorded.

Longevity in DanBred's breeding goals

Longevity has been part of the breeding goals for DanBred Landrace and DanBred Yorkshire since 2006. It is defined as the probability that a sow will be mated after her first litter, which serves as an indicator of the reproductive lifetime of the sow.

Phenotypic records on longevity are obtained from DanBred's multiplier herds. The phenotype of longevity is available for individual sows at the same time as recordings of litter size of first parity. Thereby, you avoid a time lag, which would often be problematic if longevity was recorded over the total lifetime of the sow.

per sow in the two herd types. On average, DanBred multiplier sows have 2.2 litters, which is below the average number of litters for a DanBred production sow. This results in a discrepancy between longevity in production sows, in which the trait has to work (or to be expressed), and sows in multiplier herds, from which the information is collected.

New breeding methods for longevity

In DanBred, there is an increasing focus on the sow's longevity. A new Ph.D. project at the Danish Pig Research Centre seeks to improve the methods used to select for longevity in the DanBred breeding program, and thereby increase the genetic progress in longevity.

The main goal of the project is to

investigate the challenges surrounding the discrepancies between data on longevity from multiplier herds and the longevity of production sows. These discrepancies can be attributed to different culling strategies in multiplier and production herds. The project will use longevity data from DanBred production herds to develop mathematical models that will further improve the selection for longevity in the DanBred breeding program and increase the genetic gain in future selection.

"Using data from production herds rather than data from multiplier herds will solve the first challenge in relation to breeding for longevity, but it will also create new challenges. Production sows are rotationally cross-bred. This is a challenge, as most of the breeding value estimation methods

are based on purebred animals, and these methods have primarily been extended to only cover breeding value estimation of F1 offspring. However, we will solve this challenge by using relatively untouched methods for genetic analysis in cross-bred animals regardless of their composition of breed," says Ph.D. student Bjarke Grove Poulsen, who just started the project.

Improving the method for selection of longevity in the DanBred breeding program will increase the robustness and sustainability of future DanBred sows. ☞



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Svinekongressen	Denmark	22. – 23. October 2019
OPORPA	Mexico	23. – 26. October 2019
Cremona Livestock Exhibition	Italy	23. – 26. October 2019
Indagra	Romania	30. oktober – 2. November 2019
NutriFair	Denmark	15. – 16. January 2020
Pork Congress South Dakota	USA	15. – 16. January 2020
Pork Congress Iowa	USA	22. – 23. January 2020
Pork Congress Minnesota	USA	28. – 29. January 2020
AgroFarm	Russia	4. – 6. February 2020
AMVECAJ	Mexico	6. – 8. February 2020
AgroSpring	Ukraine	18. – 20. February 2020
Congreso GITEP	Argentina	7. – 10. March 2020
Dutch Pork Expo	Netherlands	21. – 22. April 2020
CAHE	China	May 2020
Pig & Poultry	United Kingdom	12. – 13. May 2020
AMVEC	Mexico	12. – 14. May 2020
Balmoral Show	Ireland	13. – 16. May 2020
NoviSad Exhibition	Serbia	May 2020
Agricultural Days	Hungary	May 2020
Livestock Philippines	Philippines	28. – 30. May 2020
International Pig Congress	Ukraine	2. June 2020
World Pork Expo Iowa	USA	3. – 5. June 2020
National Ploughing Show	Ireland	15. – 17. September 2020
SPACE	France	15. – 18. September 2020
Vietstock	Vietnam	14. – 16. October 2020
Golden Autumn	Russia	October 2020
Svinekongressen	Denmark	October 2020
OPORPA	Mexico	October 2020
Elmia Lantbruk	Sweden	21. – 23. October 2020
Cremona Internation Livestock Exhibitions	Italy	October 2020
Indagra	Romania	28. October – 1. November 2020
EuroTier	Germany	17. – 20. November 2020





SOPHISTICATED DATA-BASED MODEL PROTECTS THE BREEDING PROGRAMME FROM CHROMOSOMAL DEFECTS

First published June 30, 2019

FERTILITY: During the formation of egg and sperm cells, or the separation of chromosomes immediately after conception, errors might occur. This applies to humans as well as pigs. Such errors might influence fertility. Thus, the Danish Pig Research Centre (DPRC) has developed and implemented a sophisticated data-based model in the DanBred Breeding Programme to minimise the risk of chromosomal defects. This model is integrated in the selection for the trait 'Male fertility' in DanBred Duroc and the trait 'LP5' (Live piglets on day 5 after farrowing) in DanBred Landrace and DanBred Yorkshire.

In all mammals, humans and pigs included, the body consists of trillions of cells. Within these cells, there are genes which are necessary for the body functions. These genes are encoded in the DNA that are coiled into structures called chromosomes. Genes play a vital part in the DanBred

Breeding Programme which ensures the best genetics, not only in the breeding nucleus but also in production herds.

"For instance, some pigs carry genes that promote their daily weight gain, their ability to survive, or their fertility in comparison to other pigs. The essence of the DanBred Breeding Programme is to continuously mate the pigs with the best genes to improve these traits for all future generations. However, in some instances, chromosomal defects may occur when genes are passed on between generations. This applies to pigs as well as human beings," says Birgitte Ask, who is a Senior Scientist at the Danish Pig Research Centre (DPRC), which manages the research and development of the DanBred Breeding Programme.

Fertility is the goal

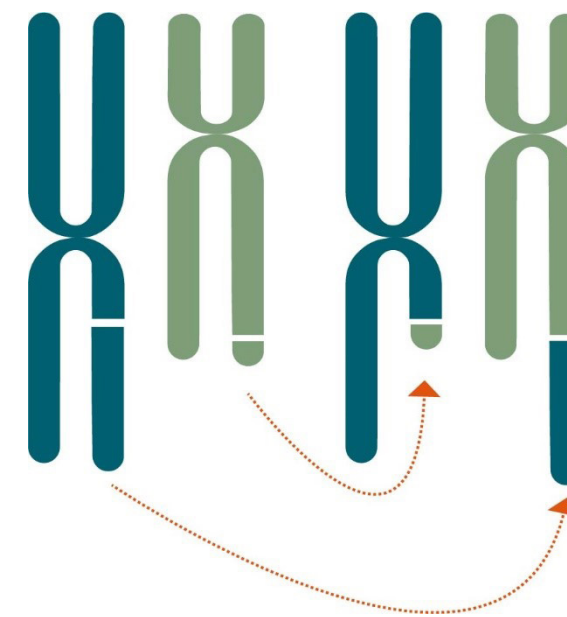
The risk of inherited chromosomal defects, such as the so-called translocations, may be reduced substantially. In a French study,

including several pig breeds, inherited translocations were estimated to appear in approximately one out of 200 normal functioning young purebred boars (0.5%). The prevalence in DanBred pigs is unknown. However, far from all translocations affect the fertility of pigs. Therefore, AI boars should not necessarily be culled just because a translocation has been detected.

"During the formation of germ cells, the chromosomes are segregated to pass on half of the gene pool to the offspring. In the earliest stage after conception, the chromosomes of the sow and boar fuse together, and their offspring inherits half of the genes from the dam and half from the sire. Occasionally, this fusion of the chromosomes is defective. A reciprocal translocation is a defect where parts of non-matching chromosomes are fused, so that, for example, a part of chromosome 7 is fused to chromosome 14 and vice versa. This may, sometimes, result in reduced fertility,

What are translocations?

During the formation of gametes and in the earliest stage after conception, the chromosomes first segregate within the gametes, and then when joined, the chromosomes from the boar and the sow fuse together. Thereby, the offspring inherit half of their mother's and half of their father's genes. However, in a few cases the segregation or fusion is imperfect. Part of one chromosome, say chromosome 1, may be swapped with part of another chromosome, say chromosome 7. In some cases, though not all, such a translocation results in some genes no longer being expressed correctly, which may ultimately lead to reduced fertility.



but certainly not always," says Birgitte Ask.

Therefore, the DanBred Breeding Programme focuses on targeting translocations and other possible chromosomal defects that are malicious for fertility, whilst simultaneously maximising genetic gain.

- This data-based model ensures that we continue with only the best selection candidates in the DanBred Breeding Programme to achieve the highest possible genetic progress.

Birgitte Ask, Senior scientist, DPRC

Accurate testing is key

Accurate testing is key, Birgitte Ask emphasises:

"There are at least two options to test for the presence of chromosomal defects such as translocations. The least costly method is karyotyping at a rate of at least 65€/animal. However, it is also a relatively inaccurate test, and it may show a chromosomal defect, which is in fact not there, or it may not detect actual defects. It is, therefore, risky to only use karyotyping as criteria for the final approval of an AI boar. The alternative method (FISH test) is by far more accurate, but also expensive at a rate of at least 270€/animal. Therefore, for economic reasons alone, this is not a feasible solution in a commercial breeding programme with thousands of potential AI boars annually," states Birgitte Ask.

"Most importantly, both tests incorporate the risk of culling top breeding boars with no problematic translocations - and thereby risk losing genetic progress. Instead, we have

developed a data-based model that protects us from any chromosomal defects with detrimental effects on fertility," says Birgitte Ask.

Data-driven progress

To protect the DanBred Breeding Programme from any detrimental chromosomal defects, a sophisticated data-based model was developed and integrated in the selection for the trait 'Male fertility' in DanBred Duroc in 2015 and for the trait LP5 (live piglets on day 5 after farrowing) in DanBred Landrace and DanBred Yorkshire in 2016. Birgitte Ask reveals how the data-based model works:

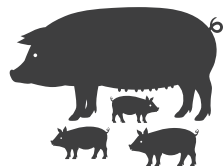
"In order to identify boars or sows with a translocation detrimental to fertility, we investigate their estimated breeding values for the traits male fertility and LP5. If the breeding value is substantially lower than expected, i.e. lower than what might be caused by random fluctuations, then this is a clear indication of chromosomal defects being the cause. Consequently, the animal will become irrelevant for the breeding nucleus, and its entire offspring will be equally irrelevant as selection candidates for the next generation. This way, we can prevent chromosomal defects in AI boars that would have otherwise been detrimental to reproduction results in production herds. Moreover, we can prevent the passing on of detrimental chromosomal defects to future generations," says Birgitte Ask.

"This data-based model ensures that we continue with only the best selection candidates in the DanBred Breeding Programme to achieve the highest possible genetic progress," Birgitte Ask concludes.

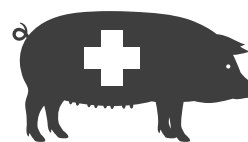


DanBred Hybrid

The most prolific hybrid for production of optimal finishers



DanBred Hybrid has great mothering abilities and is docile



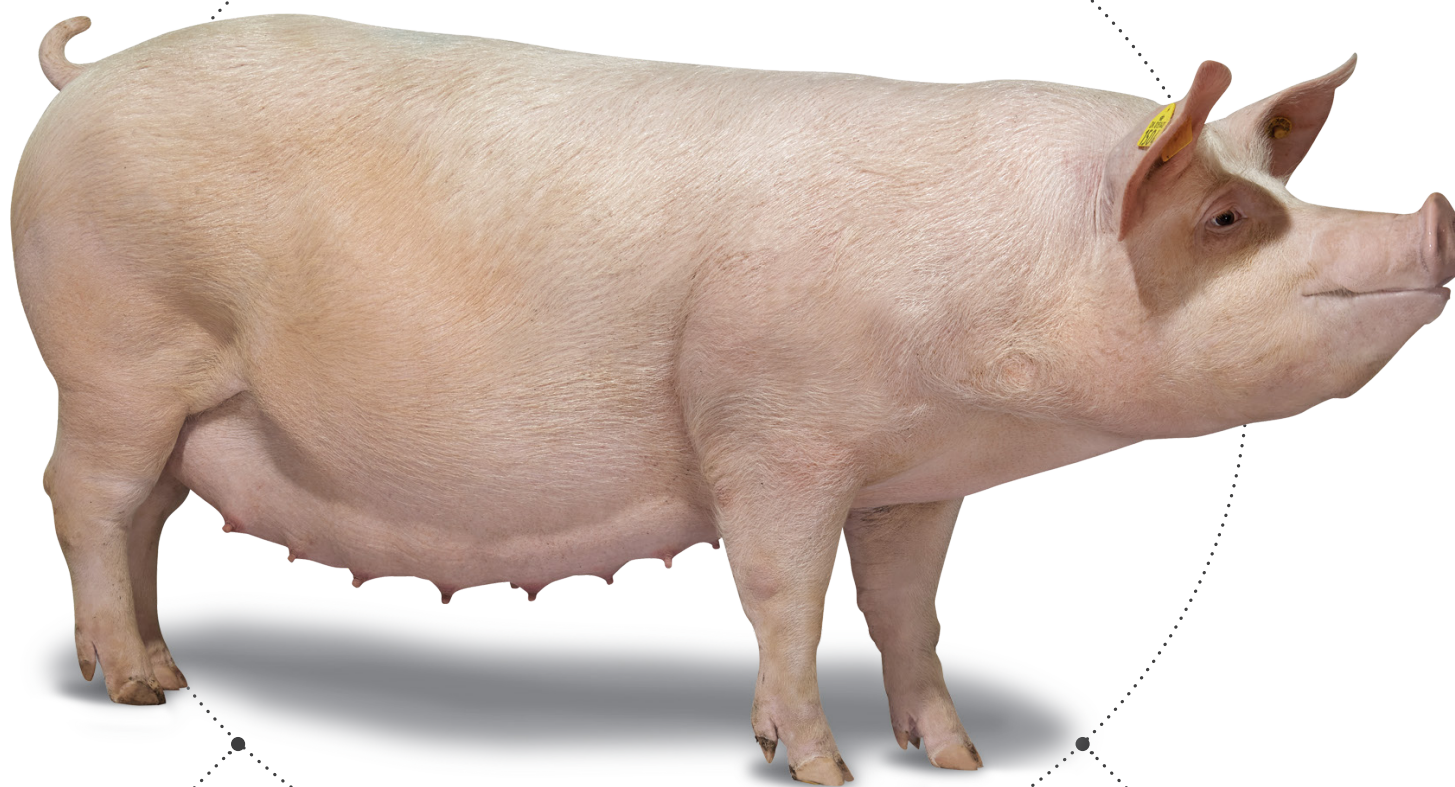
DanBred Hybrid has a good longevity, and, thus, a large lifetime production



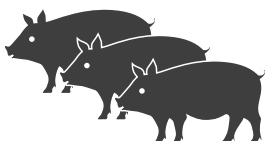
DanBred Hybrid has fast-growing and feed efficient offspring



DanBred Hybrid contributes to sustainable production of pork



DanBred Hybrid produces many robust 'full value pigs'



DanBred Hybrid produces very large litters with high survival rates

