Never Stop Improving

Genetic Improvement in the Pig Industry

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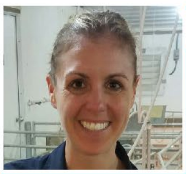


Lindsay Case

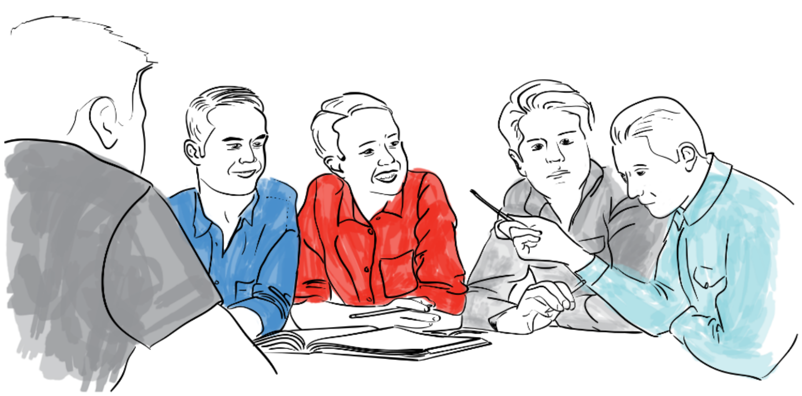
Lindsay Case leads the Genetic Services team for the Americas at PIC, focused on ensuring PIC's genetic technology improves the efficiency and productivity of commercial farms and food systems. The genetic services group is continually motivated by seeing improved profitability of pork producers through a combination of genetic potential and on-farm support as across multi-disciplinary teams.

Saskia Bloemhof

Saskia Bloemhof-Abma is PIC's technical communication manager. Her continuous focus is to exchange technical information in an easy to understand manner that helps PIC's customers to become the most successful producers globally.

The domestication from the wild boar to the domestic pig centuries ago was the onset of genetic improvement in pigs. Then afterwards, different breeds and lines were developed. At the start of the 20th century herd books in Europe started to maintain pedigree records and started selection on physical appearance. This continued in the 1950's by focusing on backfat reduction and growth rate improvement through measuring these traits on animals. At the same time, physical appearance was still very important. As data recording methods and genetic evaluation methods evolved, breeding goals changed. Additionally, at the same time, pig breeding moved from genetic improvement through herd books towards breeding specific lines by breeding companies.

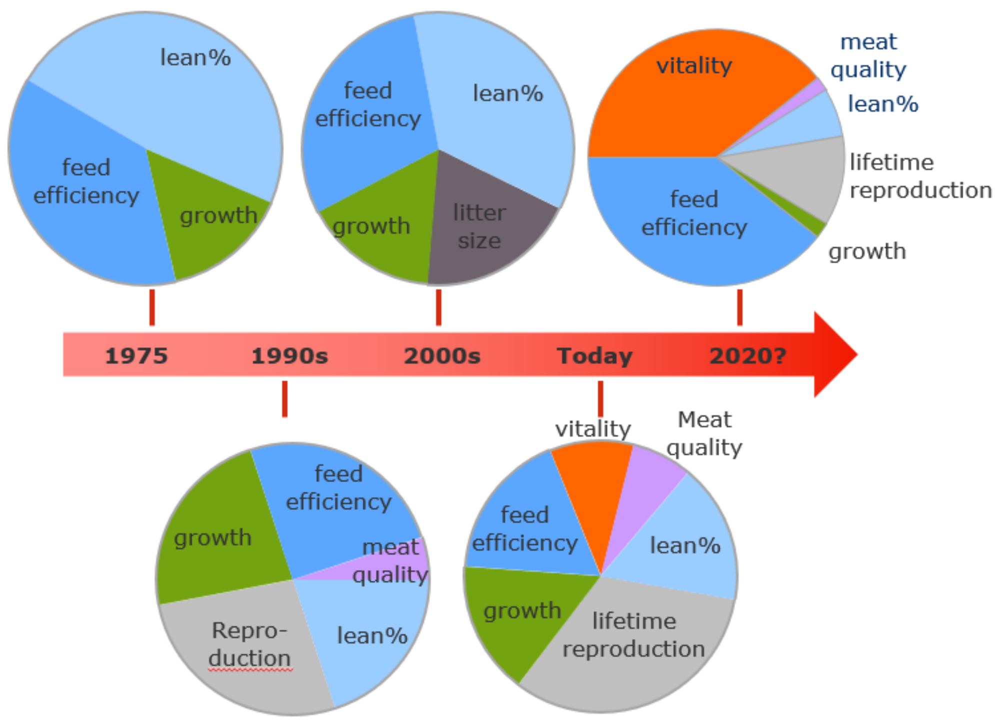
PIC started in 1962 in the UK as a small group of Oxford farmers that wanted to create the highest quality pig on the market by combining the latest science, pig biology and pork production economics.



The introduction of Best Linear Unbiased Prediction (BLUP) in 1991 was a real game changer. With BLUP it became possible to estimate breeding values using information on relatives while correcting phenotypes for systematic influences.

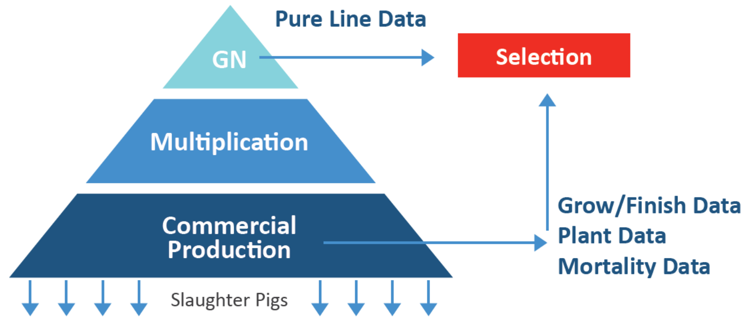
The introduction of BLUP resulted in huge changes in production. For instance, average production in the USA has changed from 11.5 total pigs per litter in 2004 up to 14.5 total pigs per litter in 2018 (*source: PigCHAMP benchmarking*). Growth rates have improved from 1.27 lb/day in 1980 to 1.61 lb/day in 2016 (*Tokach et al., 2016*).

Breeding goals have changed because of changing economics, as well as changes in relevance and measurability of traits. Today traits, with low heritability that require extensive data recording, become more and more important. Over time breeding goals have changed from sole focus on physical appearance, feed efficiency, lean % and growth to today's breeding goal with focus on lifetime reproduction, robustness of pigs, and meat quality. However, feed efficiency and lean % remain included due to its economic impact.



Within every genetic improvement program, elite genetic farms are producing boars and gilts. On these farms detailed data capture is performed which includes the performance potential of each individual pig. These genetic farms have a high health status, higher amounts of labor per pig, are generally located in temperate climates and animals are purebreds targeted for selection purposes.

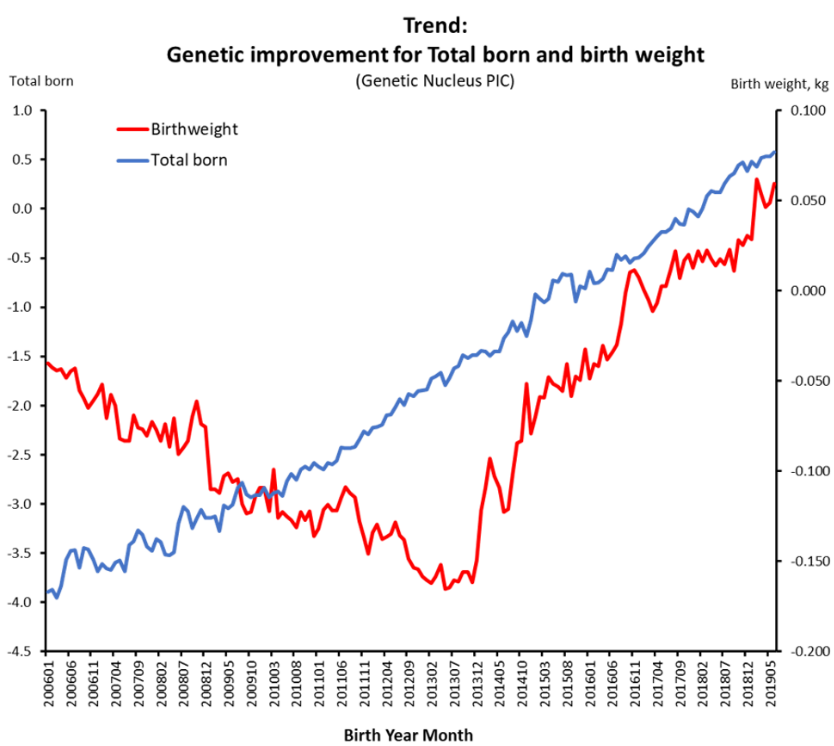
The environment in genetic farms is different from commercial production systems where focus is on low cost production and health status and is often compromised by disease (PRRSv, PED, APP, Mycoplasma etc.). Additionally, the commercial pig is a crossbred pig, typically the product of an F1 female and a terminal boar. Studies have shown that animals that perform best in a genetic environment might not always be the best animals in a commercial environment and might even re-rank. However, pigs must perform in a range of environments from Iowa, USA to Yucatan, Mexico to China.



To select pigs that perform best in commercial systems, PIC introduced its Genetic Nucleus Crossbred program (GNX-bred program) in 2003 and has been using it ever since. This program allows PIC to test elite genetics in commercial environments. Young elite boars are used to produce crossbred pigs in real-world production facilities to measure and select for robust, predictable commercial performance. The sow farms and finishers are located across four continents, and located in pig-dense areas, having conventional health and typical commercial production environments.

The introduction of Relationship-Based Genomic Selection (RBGS) into PIC's genetic program in 2013 has increased the traditional rate of genetic progress by over 35% per year for all traits, product lines and commercial products. This translates to a profit improvement of $3.50-to-$4.00 per pig per year. RBGS replaced the assumed pedigree-based relationship between animals in the traditional BLUP genetic evaluation by the actual genomic-based relationship between animals.

In PIC's genetic farms at the top of the pyramid, they have seen significant advancement in traits that directly impact the efficiency, throughput and robustness of pork production. This is a direct result of the introduction of RBGS and other on-going investments in technology.



A specific example of this additional value is the impressive change in both total born and average piglet birth weight. PIC has been measuring individual piglet birth weight for several years and has incorporated it into the selection process while implementing RBGS. As a result, the PIC genetic farms have been able to realize an improvement in total born of over 1.5 pigs per litter. Simultaneously, direct selection on individual piglet birth weight has led to an increase of birth weights by over 100 grams per piglet. Total born is a critical measure of success on a sow farm, but if birth weight and survivability of piglets are low, the value of increased total born is minimal.

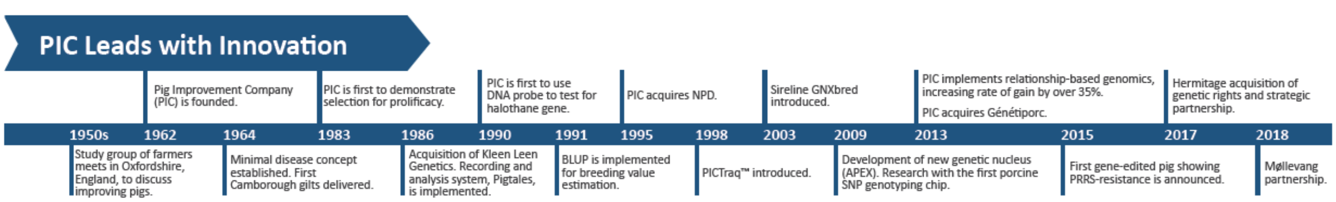
Now that birth weight is also increasing, these additional pigs are more viable and will increase the producers' productivity and profit potential. Linked to the improvement in birth weight, pre-wean survival has seen a sharp improvement of 0.8 percentage points average per year for the last five years.

Maternal improvements at the genetic farm level take approximately two-to-three years to disseminate through a multiplication system to the commercial level. Now, approximately four years after implementation of RGBS, customers are starting to see the impact from this improved rate of gain at their commercial sow farms. The full benefits of these genetic changes in PIC lines are being observed as commercial finisher pigs start reaching market. PIC maintains a customer database of commercial performance data reproductive results and growing pig performance data in North and South America.

The database includes reproductive results from over 710,000 sows and performance data of 6.3 million growing pigs. The performance data are showing strong year-over-year gains. The phenotypic trends of traits ranging from total born to feed conversion to average daily gain are showing trends equal to or greater than the predicted genetic trend.

The next step in the long tradition of innovation in pig breeding is the utilization of sequence information. The genome of the domestic pig has around three billion nucleotides, similar in size to humans. With the current genomic technology 60,000 locations on the pig genome are captured. With full sequence information available, PIC will be able to improve the understanding of the genotypes that impact phenotypic traits. This will accelerate the rate of genetic improvement. Genome sequence information can help to improve the rate of genetic improvement by optimizing the genomic based relationships between animals. Other possibilities include identifying genes that can impact resistance to diseases that challenge the pork industry.

Another advancement that will allow acceleration of genetic improvement are gene-editing techniques. Genus plc announced in 2015 that in collaboration with the University of Missouri it was able to produce a PRRSv resistant pig. The PRRSv resistant pig had been developed using gene-editing technology and does not contain any foreign DNA or any new combination of genetic material. Once ready for market this will save millions of pigs from dying from this disease.



Clearly, genetic improvement of the pig has rapidly progressed over the past 50 years moving through various levels of technology utilization. The next window of time promises to be more exciting as new technologies evolve that benefit global food production.

Our future – and yours – has never looked so bright, as PIC continues to deliver on our promise to Never Stop Improving.