KRMIVA

U.S. PUREBRED SWINE & U.S. SWINE GENETICS SYSTEMS

ČISTOKRVNE SVINJE I GENETSKI SUSTAVI U SAD-u

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SUMMARY

Remember, to maximize genetic potential the genetic source that you rely on must be making constant genetic progress. This is done by combining record keeping systems, testing programs, molecular genetics and genetic evaluation systems based on BLUP statistical methodology into a genetic improvement program. A comprehensive genetic improvement program allows genetic suppliers to make annual genetic improvement. Selections should be made according to genetic potential, compatibility (heterosis), and health requirements. Ultimately in commercial pork production, selection and crossbreeding are combined to achieve the highest level of performance

INTRODUCTION

In today's competitive worldwide pork industry a "Genetic System" is essential regardless of the size or type of swine operation. For pork producers the primary interest when selecting a genetic source is improvements in efficiency of production and end product quality that result in increased profitability. A complete genetics program, like that offered by National Swine Registry, combining state-of-the-art genetic selection with the genetic diversity of four breeds that can be combined in a mating system achieving 100% heterosis allows you to meet these goals. The U.S. Purebred Swine Breeds represented by the National Swine Registry include Yorkshire, Landrace, Duroc and Hampshire. The U.S. purebred industry continually works to produce and improve genetics that excel in numbers of pigs born alive, milking ability in sows, average daily gain, feed efficiency, feed intake, superior loin muscle, lean carcasses, durability and high health animals. In addition, U.S. purebred breeders realize the needs of today's consumers and produce genetics that have excellent meat quality and a preferred taste over other competitive meats. The intent of this paper and presentation is to introduce the U.S. Purebred Swine Breeds and the genetic systems they utilize and offer.

U.S. PUREBRED SWINE BREEDS

Maternal lines are the foundation of an efficient pork production operation. Landrace genetics are a mainstay in American and world sow herds. Landrace are prolific sows that farrow large litters and are exceptionally heavy milkers. They are noted for their productivity and longevity in confinement operations. Not only can Landrace genetics provide more large pigs at weaning but

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they also supply the genetics to produce productive market hogs. Landrace are known for their length of body and high percentage of carcass weight in ham and loin. The goal of the Yorkshire breed is to be a source of durable mother lines. Yorkshire genetics consistently produce more pigs born alive and as the "Mother Breed" they produce more pounds of weaned pigs due to their superior milking ability.

The herds comprising the four major U.S. breeds create a national nucleus of over 15,000 sows (Table 1) that can support genetic improvement in nearly 2 million sows of commercial production. Over 1.25 million performance records have been accumulated in a genetic database that is the largest database of documented performance tied directly to ancestral records in the world.

Table 1. Nucleus population size and performance records in databases as of October, 2003.
Tablica 1. Veličina osnovne populacije i zapisi o performansi u banci podataka za listopad 2003.

Breed Pasmina	Active sires Aktivni nerasti	Active dams Aktivne krmače	Post weaning records Zapisi nakon odbića	Reproductive records Reproduktivni zapisi
Duroc	639	4,578	204,758	102,132
Hampshire	483	2,385	108,177	99,810
Landrace	245	1,966	92,223	67,263
Yorkshire	816	5,729	404,534	288,676
Total	2,183	14,658	809,692	557,881

As a terminal sire Durocs are known for lean gain efficiency, carcass yield and product quality. Duroc genetics provide the opportunity to market hogs that use feed more efficiently in less time. The National Genetic Evaluation programs sponsored by the National Pork Board demonstrated that Duroc sired pigs grow faster and produce a high quality carcass that is in demand from pork processors and consumers worldwide. Their advantage in muscle quality combined with their well established ability to grow fast has positioned the Duroc breed as an outstanding terminal sire choice. The Hampshire breed is recognized by their distinctive belt, universally known as the "mark of a meat hog". They are the leader in leanness and muscle with good carcass quality, minimal amounts of backfat and large loin eyes. Today's Hampshire's continue to lead the way in lean muscle growth with the advantage of improved meat quality through DNA technology. Hampshires and Durocs both complement the modern whiteline (Yorkshire x Landrace) sow by maximizing heterosis for efficient market hog production. Both Durocs and Hampshires can also offer good mothers that add durability and longevity in crossbreeding programs to produce breeding females.

SWINE TESTING AND GENETIC EVALUATION SYSTEM

The Swine Testing and Genetic Evaluation System (STAGES) is one of the most technically advanced genetic selection programs available. Performance records and pedigree information are combined in a statistical procedure known as Best Linear Unbiased Prediction (BLUP) by an "animal model" that describes gene flow over time and biology of the trait. Pedigree information allows performance records of progeny, cousins, sibs, parents and grandparents to aid prediction of genetic merit. Comparisons can be made across herds where genetic ties are present and when sires have been used in multiple herds through artificial insemination. Daily STAGES evaluations estimate expected progeny differences (EPDs) for each trait and bioeconomic indexes are calculated to use in selection of animals for combinations of traits. Special emphasis is given to traits with significant economic impact, including number born alive, litter weight, days to market, backfat depth and pounds of lean. Data are also collected and analyzed for weaning to service interval, birth weight, loin color, intramuscular fat, and ultimate pH.

In 1999 three significant changes were made to the STAGES index procedures they were 1) carcass and growth evaluations were moved from a 230 to 250 pound off-test weight to reflect the increased average market weight in the U.S., 2) an EPD for pounds of fat-free lean adjusted to 250 lb live weight was introduced, and 3) a curvilinear economic relationship was developed between carcass value and measurements associated with leanness. The change to a curvilinear approach for carcass leaner accounts for the facts that for U.S. packers extremely lean carcass (< 17 mm) have increased incidence of pork quality problems and in some instances receive lower premiums than carcass with > 17 mm and that pigs greater than 28 mm in backfat thickness are discounted to a greater extent.

A successful genetic improvement system should include four points; 1) accurate complete performance records, 2) assessment of genetic merit, 3) indexes, and 4) selection of the highest ranking boars and gilts based on the selection indexes. This is what the STAGES program is designed to do. In order for the breeders participating in the STAGES program to have accurate and complete performance records they pay strict attention to contemporary groups, data collection and data submittal. The basis of a good genetic evaluation is having the ability to compare animals versus their contemporaries. A properly designed group includes animals that are: 1) the same breed or breed composition, 2) the same sex, 3) of similar age, and 4) have had similar care consisting of the same housing, nutrition, and health status.

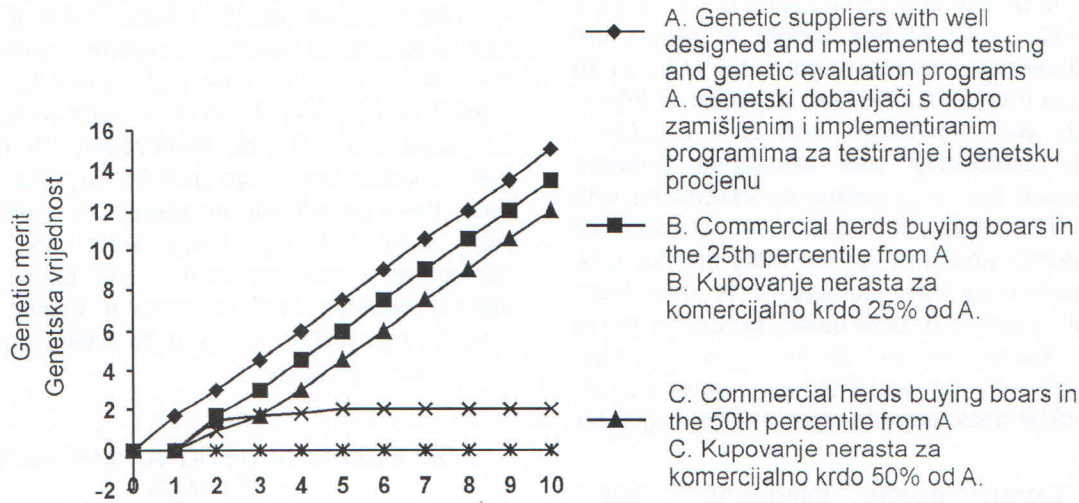
STAGES participants are encouraged to use whole herd inventory and whole herd testing which are defined as recording all litter and reporting female inventory and performance testing at least 50% of the pigs weaned. Contemporary groups are also encouraged to consist of at least 20 pigs from at least five litters and at least two sires. Testing smaller groups will lead to inadequate comparison and less reliable EPDs. In addition, STAGES participants utilize real-time ultrasound technicians that are certified by the National Swine Improvement Federation. Accuracy of performance records is also assured by the implementation of electronic data transfer from participating herds to the central office for data processing. This eliminates copying of data and reduces errors.

The average genetic improvement across all four pure breeds (Duroc, Yorkshire, Landrace and Hampshire) over the last eight years for days to market and backfat depth have been reductions of 2.7 days and 4.5 mm, respectively. While kg of lean, number born alive and 21 day litter weights have been genetically increased by 1.36 kg, .25 pigs, and 1.3 kg, respectively. In addition, considerable progeny testing has been done to identify superior lines in muscle quality, as the industry has shifted its focus to eating quality and consumer satisfaction.

SELECTING GENETIC SUPPLIERS AND ANIMALS

How should you identify a genetic source? The first step is to evaluate the suppliers complete genetic improvement program. Figure 1 describes the importance of evaluating genetic improvement programs. The rate of genetic improvement in commercial herds will parallel the genetic progress made by the genetic supplier's herd. The first three lines (A, B, C) of the graph show the expected improvement in genetic merit when the genetic suppliers are making annual genetic progress. The genetic merit of commercial herds (B and C) closely follows that of the genetic supplier. By purchasing boars in the top 25 percentile, the commercial herds can approach the genetic level of the genetic supplier. However, purchasing boars in the top 50 percentile also offers excellent genetic progress to the commercial producer. Genetic progress does not occur when boars are purchased from genetic suppliers where genetic improvement is not realized (D and E) result in inconsistent genetic progress. This is because the genetic merit of the boars purchased is not improving. Commercial herds that purchase average boars from genetic suppliers making annual genetic progress have an advantage over commercial herds that select and purchase the very top boars from unimproved genetic suppliers. For this reason, identification of genetic suppliers is of primary importance. Selection of individual animals from within these herds is secondary.

Figure 1. Rate of genetic improvement
Slika 1. Stopa genetskog oplemenjivanja



It is also important to evaluate genetic trends. Genetic trends for a breed or an individual herd will show the annual improvement in genetic progress that has occurred for each trait or index. Figures 2 through 5 show some selected genetic trends for U.S. Purebred Swine. Select a genetic supplier that is making annual genetic improvement in your traits of importance. One common misconception is that an average animal has an EPD of 0 for a given trait. But the average EPD is dependent on the genetic base year and the genetic trend in the population. The genetic base of a population is the original group of animals at the initiation of testing and selection. The average EPD of this population will be zero, and this genetic base will be a point of reference for future generations. A genetic base year is therefore, the time period during which the genetic base animals are born. The STAGES genetic evaluation program uses a moving base. The base year for maternal traits is set four years prior to the evaluation and three years prior to the evaluation for terminal traits as depicted in Figure 6. This base changes nightly, truly reflecting a dynamic population. With this moving base the breed means will hover close to zero for EPDs and 100 for indexes. Superior

Figure 2. Duroc genetic trend for days to 113.5 kg
Slika 2. Genetski trend Duroca za dane do 113,5 kg

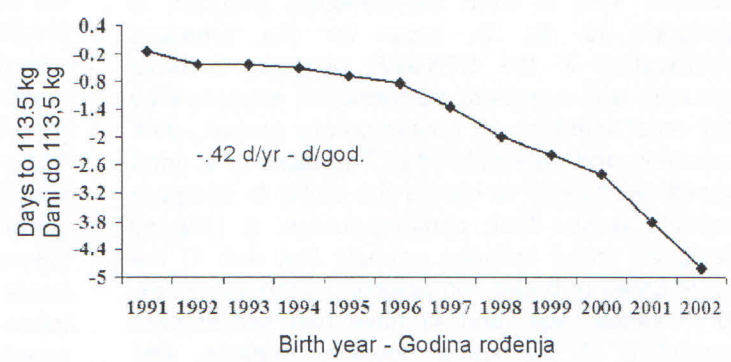


Figure 3. Hampshire genetic trend for backfat
Slika 3. Genetski trend Hampshire-a za leđnu masnoću

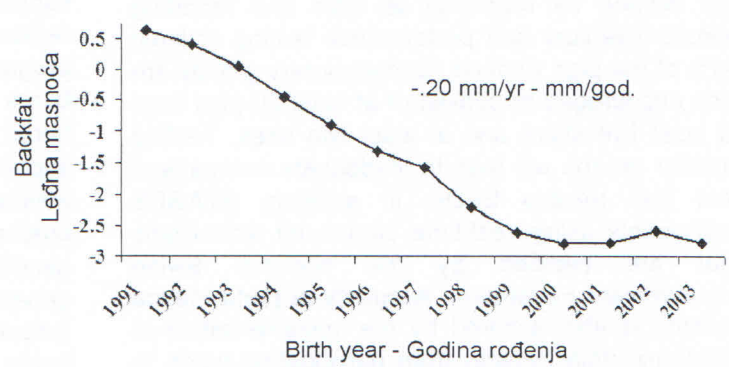


Figure 4. **Landrace genetic trend for number of pigs born alive**

Slika 4. **Genetski trend Landrace-a za broj živorođenih svinja**

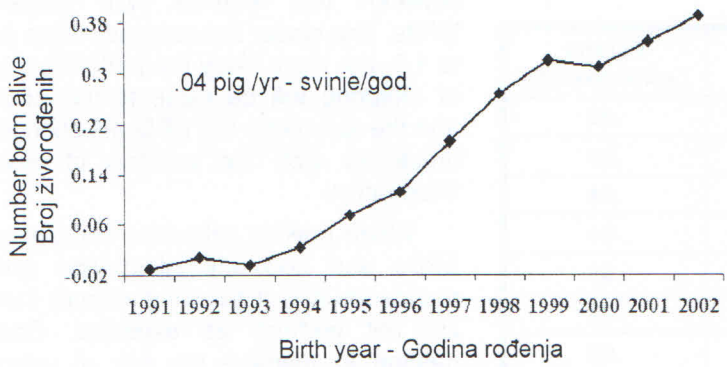


Figure 5. **Yorkshire genetic trend for 21 d litter weight**

Slika 5. **Genetski trend Yorkshire-a za težinu legla 21. dana**

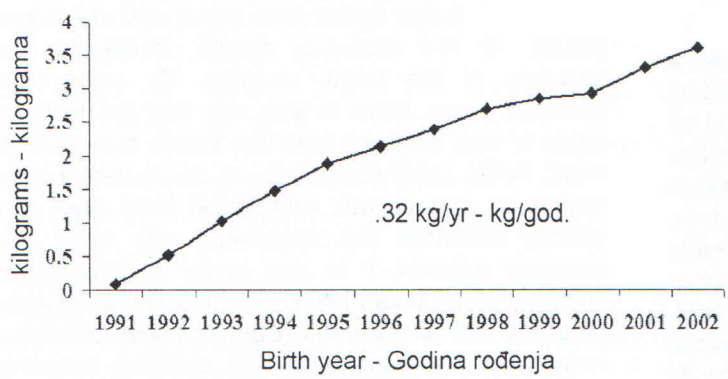
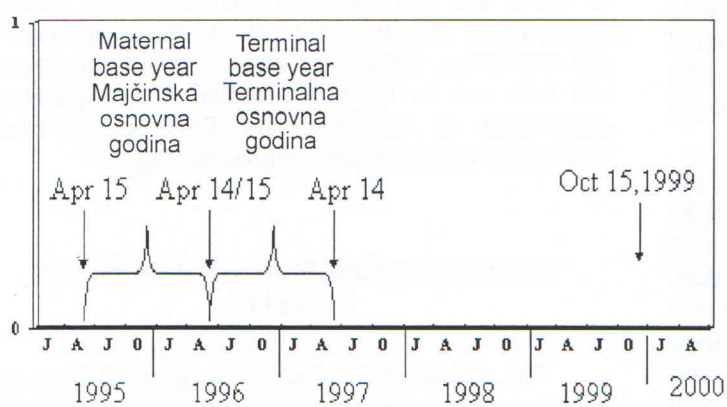


Figure 6. **STAGES genetic base year**

Slika 6. **STAGES genetska osnovna godina**



animals will also be easy to identify because the numbers will be relative from year to year. Essentially, the EPDs are adjusted daily for genetic trend.

An evaluation of genetic trends shows the annual genetic improvement that has occurred. Next evaluate herds within each program. STAGES information can be used to compare herds in the same breed by studying rankings in traits of interest for animals used in one herd compared to other herds. The third step is to compare the herd's average genetic merit to that of the breed. Select a herd that has above average genetic merit for the traits of importance in your operation. Finally, this information is combined with your health requirements and those herds meeting both genetic and health needs should be considered.

When selecting individual animals based on EPDs, select the highest-ranking animals that meet all health and phenotypic requirements. However, this does not imply that only the number 1 sire or even only animals in the top 10 or 20% in a breed should be used. Any boar in the top 50% is above average and will provide genetic improvement. Remember, the population of animals, the herd that you are selecting in and the genetic improvement program are the most important criteria. Concentrate on identifying superior sires through the across-herd sire summary and then select top ranked animals from on-farm programs. Because of the larger number of heads required for replacement females selection should be made in the top 75%.

When making any selections remember that EPDs are "estimates" of genetic merit based on varying amounts of information and may change over time as new information is added. The amount of new information will change the accuracy and how well progeny perform will change the EPD. The accuracy value reflects the amount of information that was available to calculate each EPD and should be used as an aid in deciding between two animals with similar EPDs. Regardless of accuracy, the EPD is the best estimate of genetic merit available.

Table 2. Possible changes (+/-) associated with accuracies for growth and maternal traits

Tablica 2. Moguće promjene /±/ u svezi s točnošću za rast i majčinske osobine

Accuracy Točnost	NBA	LWT21	Days Dana	Backfat Leđna masnoća
.10	.52	9.51	5.80	.06
.20	.46	8.45	5.16	.05
.30	.40	7.40	4.51	.04
.40	.34	6.34	3.87	.04
.50	.29	5.28	3.22	.03
.60	.23	4.23	2.58	.03
.70	.17	3.17	1.93	.02
.80	.11	2.11	1.29	.01
.90	.06	1.06	.64	.01

Source - Izvor: NSIF - FS13

STAGES information can also be used as a decision making tool when planning breeding programs. Mating decisions can be made based on EPDs. Planned matings can be either positive assortative (high to high and low to low), negative assortative (high to low and low to high) or random. Positive assortative mating would be desirable among the top 5% of seedstock animals in order to produce offspring of extremely high genetic merit. This would also be the situation on a commercial farm using a rotaterminal program to produce its own replacement gilts, where the top 15% of sows are identified and mated to superior maternal line boars. Negative assortative matings would be used in an attempt to produce greater uniformity among the offspring and for matings that provide complementarity across traits. An example would be the use of terminal boars superior for growth and backfat on maternal sows to produce a large volume of lean, fast growing market hogs.

When making any selections it must also be remembered that EPDs are "estimates" of genetic merit based on varying amounts of information and may change over time as new information is added. The amount of new information will change the accuracy and how well progeny perform will change the EPD. The relationship between accuracy and the possible change of EPDs is illustrated in Table 2. The accuracy value reflects the amount of information that was available to calculate each EPD and should be used as an aid in deciding between two animals with similar EPDs. The closer the accuracy value is to 1.0, the more likely the performance of offspring will be close to the EPD and the less likely the EPD will change drastically with the addition of new information.

When making selections combining EPDs and accuracy information can reduce the risk of selecting animals that will not perform as expected. One method to manage the risk of using young, unproven sires with low accuracy is to limit the use of low accuracy boars and use proven, high accuracy boars extensively. Another, better option is to select and use larger groups of low accuracy boars, increasing the accuracy of the group average. By using high accuracy boars there is less risk that the EPD or index is very different from the boar's true genetic merit. While using several young boars, rather than relying on one or two exceptional herd sires can virtually eliminate risk associated with using low accuracy animals. It is also easier to find higher indexing young boars because of the annual genetic progress that is occurring. Both of these strategies reduce the risk associated with selecting breeding animals. However, the use of several young sires allows for a greater reduction in potential risk and may offer more potential for even faster genetic improvement. The approach with risk management is not to use any one boar too extensively. Some young boars selected may turn out to be very poor, but remember, there is an equal chance that some will turn out to be much better than expected. Regardless of accuracy, the EPD is the best estimate of genetic merit currently available.

USING CROSSBREEDING IN A GENETIC SYSTEM

The combination of superior genetics used in a crossbreeding program, and selection of animals

based on EPDs enable producers to realize maximum genetic gain and therefore maximum profit. A well-planned mating system utilizes maximum heterosis through the use of purebred animals and appropriate combinations at the parent, grandparent, and great grandparent levels. Crossbreeding is an important part of swine production systems because of improvement in efficiency from heterosis and potential to exploit differences between breeds. Heterosis, or hybrid vigor, is a phenomenon in which the performance of crossbred progeny exceeds the average of the parent animal. Heterosis has the most significant benefit in maternal performance and can result in as much as 1 additional pig per litter, 65 additional kg at 21 days, and a .15 reduction in feed conversion ratio.

In terminal programs, crossbred females, either F1 or three-way cross females, are bred to a purebred terminal boar of a breed not included in the genetic makeup of the female. All progeny are sent to market and no breeding gilts are retained from this final cross, therefore replacement females must either be purchased or produced in a separate program. This allows the use of purebreds in specialized roles (i.e. to produce only females or only market hogs) and therefore the strong characteristics of each breed can be fully utilized. Two different programs for a terminal, static cross in which all offspring are market animals as described in Figures 7 and 8. In both of these crossbreeding programs breeds that have superior genetic merit for reproduction provide the females and lines that are superior for production traits provide the males. The pigs marketed have high genetic potential for production and the sow herd has high merit for reproductive traits.

Figure 7. Crossbreeding maximizes heterosis
Slika 7. Uzgoj križanjem maksimira heterosu

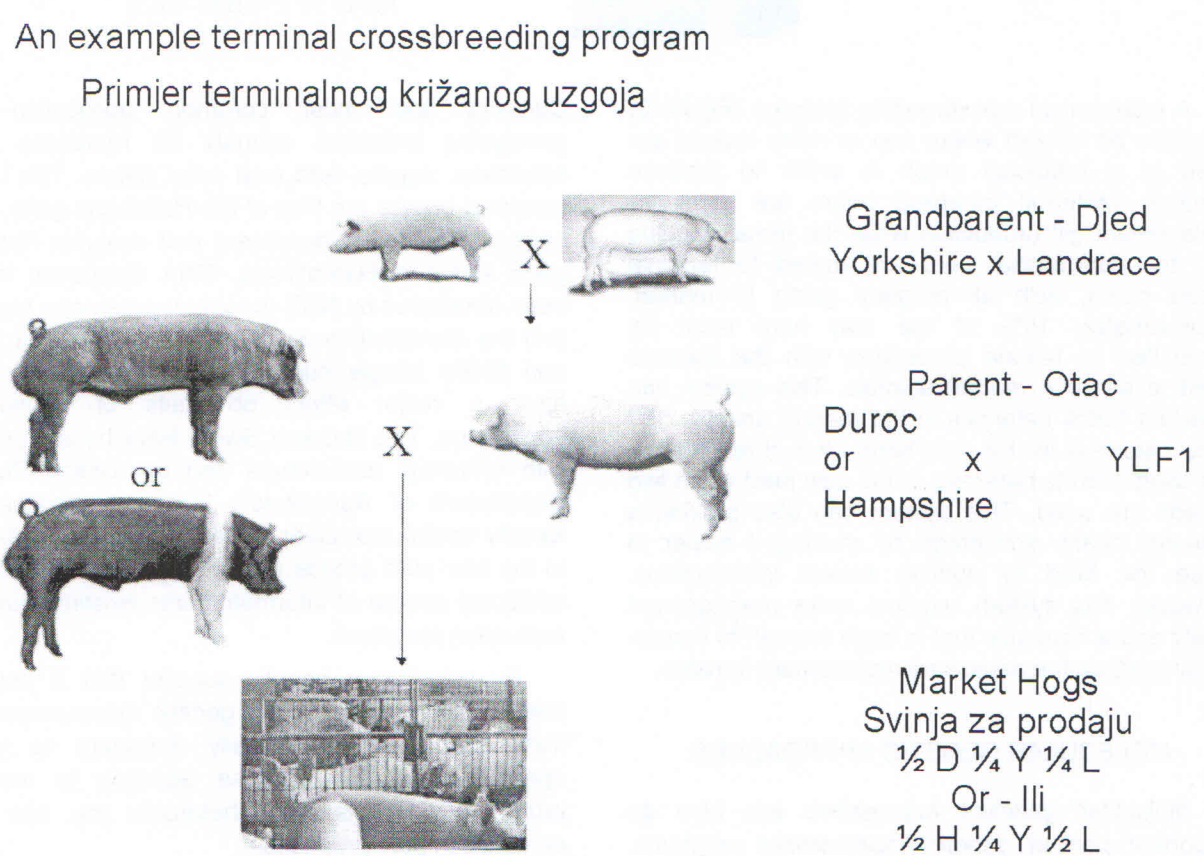
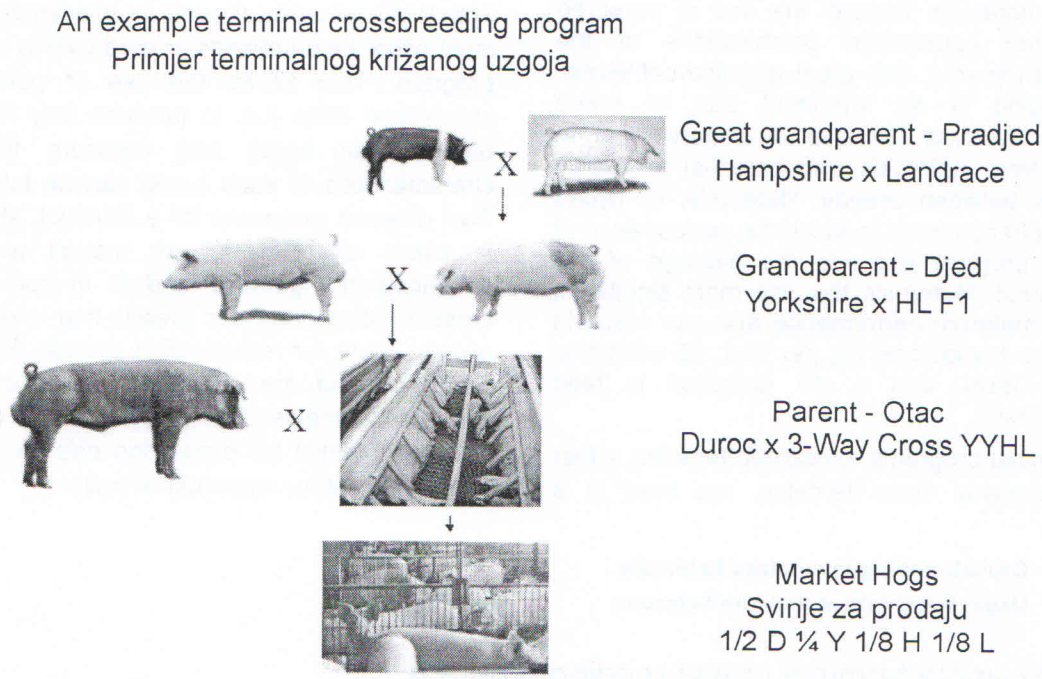


Figure 8. Crossbreeding maximizes heterosis
Slika 8. Uzgoj križanjem maksimira heterosis



A rotaterminal crossbreeding program (Figure 3) can also be utilized where two or more breeds are used in a rotational cross in order to produce females. Maternal purebred boars are used for replacement gilt production while the females going into the commercial herd are mated to terminal breed boars, with all progeny going to market. Approximately 15% of the sow herd must be committed to female production with the balance used to produce market animals. This system can maintain 100% heterosis in the market animals and 86% heterosis in the sow herd when three breeds are used or 67% heterosis in the sow herd when two breeds are used. This system can also provide a potential health advantage by making it easier to close the herd to outside animal introductions. However, this system requires extra management ability and a herd size that is large enough to consistently produce the necessary replacement females.

MOLECULAR GENETIC APPROACHES

Molecular genetics approaches are also an important part of genetic improvement programs. Currently the most common application is genotyping individual animals for mutations like halothane, napole, and coat color genes. The U.S. purebred breeds are free of the Halothane gene and have a program to document and evaluate Napole gene status in Hampshires. DNA databases have been developed by NSR for use in parentage testing and the identification of QTLs (quantitative trait loci) and SNPs (single nucleotide polymorphisms) that have a major effect on traits of economic importance. The National Swine Registry is working with university researchers and the United States Department of Agriculture's Research Service to identify useful molecular genetic information related to the four pure breeds and will incorporate it as an additional source of information into existing genetic evaluation programs.

By selecting a genetic supplier that is performance testing and making genetic improvement in traits that are economically important to your operation and paying close attention to mating programs that maximize heterosis you can be profitable in pork production.

SAŽETAK

Ne zaboravite, da bi se maksimirao genetski potencijal, genetski izvor o kojem ovisite, mora stalno genetski napredovati. To se provodi spajanjem sustava bilježenja, programa testiranja, molekularne genetike i sustava genetske procjene na temelju statističke metodologije BLUP-a s programom genetskog oplemenjivanja. Opsežan program genetskog oplemenjivanja omogućuje genetskim dobavljačima godišnje genetsko oplemenjivanje. Selekciju treba provoditi prema genetskom potencijalu, kompatibilnosti /heterosis/ i zdravstvenim potrebama. Konačno, u komercijalnoj proizvodnji svinjetine udružuju se selekcija i uzgoj križanaca kako bi se postigla najviša razina performanse.

Selekcijom genetski dobavljač koji testira performansu i radi na genetskom oplemenjivanju osobina važnih za vaš rad davanjem pune pozornosti programima spajanja/parenja što maksimiraju ketosis možete biti profitabilni u proizvodnji svinjetine.