Obtaining Intermediate and Designed Animal Groups within Hybridization Systems

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Abstract

The article presents the results of work on the development of methods for creating intermediate and designed groups of farm animals for crossing and hybridization systems using modern breeding methods. Any pig hybridization program is based on the use of specially selected lines. Crossbreeding of specialized genotypes leads to a significant increase in the production of pig products with no additional investment required. Obtaining the final hybrid is advisable to carry out on the basis of the following scheme: Stage 1 - obtaining a cross-linked pig F_1 on the basis of crossing sows of specialized maternal line and boars of the first paternal one; Stage 2 - evaluation and selection of crossed females F_1 for further use in hybridization; Stage 3 - obtaining the final three-breed hybrid on the basis of crossing sows F_1 and boars of the second paternal line. The resulting hybrid piglet is intended for fattening in order to obtain the final product. To introduce the final hybrid into production, it is necessary to evaluate the designed genotypes for combinational compatibility. That is, to evaluate the productivity of sows and replacement young F_1 and young of the final cross in a comparative aspect with the original parental forms (clean specialized lines).

Keywords: pigs; hybridization; crossbreeding; heterosis; specialized line.

Introduction

The current stage of the pig farming development is characterized by the widespread use of interbreeding and hybridization. Currently, the term “hybrid” is understood not only as a result of crossbreeding of different breeds, but as a product of selection and crossbreeding (Sokolov, Karmanov, 2014; Mikolaichik et al., 2018; Nevrkla et al., 2017; Yang et al., 2020).

At the stage of establishing a competitive domestic pig breeding, special attention should be paid to the development strategy of domestic breeding and genetic centers, which will become a source for implementing hybridization programs and organizing pig breeding on a qualitatively new genetic basis (Dunin et al., 2018; Kosko, 2016; Martins et al., 2020).

The most significant obstacle to the widespread use of hybridization methods (interbreed, pedigree-linear and interlinear) is the lack of domestic specialized breeds, types and lines of pigs that have combining ability in specific cross systems. In connection with a cardinal change in the level of pig productivity and the criteria for the quality of the products obtained, requirements for the productive and breeding value of animals sharply increased. Massive import of livestock of pigs of foreign selection allowed improving significantly the genetic potential of pig breeds. But today, one of the priority tasks of pig breeding is the creation of domestic specialized genotypes (Rachkov et al., 2016; Sharnin, 2016).

Accordingly, to create large massifs of pigs that can stably provide high productivity for a long time with various variants of pedigree-linear mating is one of the central problems of domestic pig breeding.

To achieve the pointed goals, it is necessary to develop a technology for producing specialized meat-cross pigs for intensive production of pig products based on the use of index and genomic selection of parental populations.

The purpose of the work is to develop a methodology for creating intermediate and design groups of animals for systems of crossing and hybridization using modern selection methods.

Methods

The studies were conducted at the Department of Animal Breeding and Genetics of the Federal State Budget Educational Institution of Higher Education Kuzbass State Agricultural Academy. The development of methods for creating intermediate and designed groups of animals for crossbreeding and hybridization systems using modern selection methods was carried out on the basis of analysis and generalization of data from specialized scientific sources and pig breeding experience.

Results

Any pig hybridization program is based on the use of specially selected lines. Crossbreeding of specialized genotypes leads to a significant increase in the production of pig products with no additional investment required (Kennedy et al., 1996; Kim et al., 2018; Houde et al., 2010; Yang et al., 2020).

Specialized lines are genotypically different groups of animals created on the basis of one or several breeds and selected (specialized) according to one or two economically useful traits, which can significantly increase the selection intensity. When these combined lines (crosses) are crossed among themselves, highly productive heterotic progeny are obtained.

The possibility of specializing maternal and paternal genotype forms is based on independent inheritance in pigs of certain groups of productive qualities (reproductive, fattening, meat) (Kozlovskiy et al., 1987; Banik, 1984; Kim, 2001; Krupa, Wolf, 2013; Przybylski, Krzecio, 2000). When creating and reproducing maternal genotypes are selected for reproductive quality, father forms are selected by fertility, growth energy of offspring, efficiency of feed use, severity of meat forms, uniform distribution of spinal fat, etc. Intensive production technology makes it necessary to meet strict constitutional strength requirements, general resistance and the viability of the offspring.

The breed (type, line) is taken as maternal one, if their sows, with appropriate feeding, are able to ensure the farrowing and good development of the numerous litters, i.e. possessing high reproductive abilities, constitutional strength and stress resistance. It is important that the maternal line is well adapted to the environmental and technological conditions of keeping. Although these requirements apply equally to the animals of the paternal line, however, they are much more important for the maternal line, since it is the maternal organism that ensures the survival and development of crossbreeds in the prenatal and lactating periods.

The choice of the initial groups of animals for obtaining intermediate genotypes should be based on the analysis of modern achievements in the field of breeding and genetics of farm animals.

Based on the fact that pork production in the Russian Federation is based mainly on the use of Yorkshire, Landrace and Duroc breeds of Canadian selection, it is advisable to create intermediate and designed genotypes specifically for these populations. At the same time, it is planned to create a specialized maternal form selected for reproductive qualities in the Yorkshire breed, the first paternal form selected for fattening qualities in the Landrace breed, and create the second Duroc form selected for meat qualities in the Duroc breed. A schematic diagram of the creation of specialized lines and the production of a final three-breed hybrid cross on their basis is presented in Figure 1.

When breeding specialized maternal lines, preference is given to the reproductive abilities of sows, and their fattening and meat qualities are maintained at a level not lower than the elite class for the breeds of the first group.

Paternal lines (first), breeding to improve fattening qualities, should have a reproductive ability and meat quality rating not lower than class I requirements, and paternal lines (second), their main sign of selection is meat qualities, the same assessment in terms of reproductive and fattening qualities.

The first paternal specialized lines should exceed the breed standard: in maturity - by 10-20 days when fattening to live weight of 100kg, and in terms of feed cost per 1 kg of growth - by 0.2kg.

The second paternal specialized lines should have a smaller fat thickness when fattening up to 100kg, respectively 0.2mm in comparison with the breed standard; carcass length - more by 3.0cm; the mass of the hind third of the half-carcass - by 1-1.5kg; the depth of the muscle at the point - 2-4mm; meat yield in the carcass - by 2-3%.

Animals of all specialized lines, regardless of the main directions of their selection according to leading characters, should have common physique and exterior characteristics characteristic of the breed used.

In addition, increased requirements are imposed on the strength of the constitution and productive longevity, general resistance and viability of the offspring. Therefore, it is necessary to pay attention to these parameters when selecting animals for reproduction.

Along with standards for specialized parental forms, it should provide standard productivity parameters for hybrid sows and commercial hybrids, which ultimately determine the effectiveness of commercial pig farming.

Creating specialized lines can be done in two ways:

1. Breeding of new specialized lines based on setting up of outstanding ancestral qualities of the ancestors with subsequent rotation of the branches according to the corresponding selection key (selection scheme).
2. The formation of specialized lines based on the improvement of already existing related groups and factory structures of the breed, as well as with their selection and selection of pairs, taking into account the accepted selection key.

Figure 1. Schematic diagram of breeding work with animal lines

Both of these ways are not mutually exclusive, in both cases, for laying specialized lines, a range of prominent ancestors and sows, preferably unrelated to each other, must be specially allocated.

The next stage is the breeding work on the implementation of the planned schemes for the withdrawal of laid lines, preservation and consolidation, and then the subsequent development of the selected ancestors' advantages in the offspring, taking into account the target standard and animal model of each specialized lines included in a particular cross.

The initial groups of boars and sows of each specialized line are formed due to highly productive animals that are relatively identical in one or more main breeding characteristics and do not have common ancestors within 4 generations.

The work on creation of specialized lines begins with the selection of the best 40-50 sows, in the herds, that are close to the model and standard of the output line by body type, development and productivity. By origin, they must belong to 8 genealogically separated groups, at least 5-6 goals in each of them. Given the same number of disparate groups, boars are selected for the sows, whose mothers were not less than the level of the target standard of the line being created in terms of productivity. Subsequently, eight branches (sows and boars) are formed from the selected groups of animals.

A uniform selection of animals according to breeding grounds is used without close related mating.

Ultimately, the specialized line represents a closed population of animals with high typification to a narrow target standard.

The selection of replacement young animals is carried out on the basis of the application of the selection index method, based on genetic and mathematical calculations. The selective effect of selection by indices is approximately 10% higher than by independent selection boundaries.

Indices are calculated for each animal separately, and breeding traits are expressed in comparable values, which are then summarized. In other words, breeding indices are used for individual rather than group assessment of animals. Sometimes the characteristics included in the index can have different dimensions and breeding and economic importance. The addition of various characters is carried out using weighing coefficients, which express the specific gravity of each character in the selection index, and reflects its selection and economic significance.

When laying specialized lines, it is important to provide the broadest possible initial genetic base. For this, based on a thorough zootechnical and genealogical analysis, it is necessary to identify a sufficient number of prolificacy record-breaking animals from related groups of boars and sows of this herd. They should possess all the valuable features and qualities necessary to achieve the

parameters of the target standard and ensure the subsequent progress of the lines created in the system of a specific cross-country based on directional selection, while maintaining a common type, constitution and high typification of product hybrids.

Note that creating specialized lines, it is important to adhere to the generation turnover scheme, that is, comply with the requirement of combining the sows of each generation of a given branch with the boar of the corresponding generation of another branch. Violation of this condition will affect the change clarity of rotational combinations and, consequently, the entire work with the line.

In the formation of each closed specialized line, in order to avoid forced inbred depression, it is necessary to create their internal structure, consisting of at least four to eight related groups (branches).

Selection work of formation specialized lines is based on:

1. Obtaining at least 5 generations from animals of the original generation. Generations are counted from the generation of the mother. For example, if a mother belongs to the initial generation, then the selected replacement pigs, her gilts, will belong to the first generation, and their offsprings to the second, etc.
2. Evaluation of young animals at an early age (the first 1-2 months of life) for the presence of a spectrum of desirable alleles of marker genes and the absence of genetic anomalies.
3. Rigid rejection of replacement young animals according to their own productivity when selecting for reproduction on the basis of BLUP-assessment.
4. The selection of animals is carried out on the basis of outbred pairing and rotation of lines based on the branched genealogical structure of the herd.
5. Fast change of generations.
6. A compulsory condition is a high level of paratypical factors (conditions of fattening and keeping animals).

An essential element of the method for obtaining intermediate and designed groups of animals for breeding and hybridization systems is the genetic examination of animals in order to exclude the population genetic abnormalities and identify correlations of DNA markers with QTL characters. Each generation of the created specialized population is subject to mandatory genetic examination to identify genetic anomalies and identify animals with the desired genotypes.

Conclusion

One of the important tasks in breeding work on the creation of specialized pig lines is the production of animals that give an appreciable effect in breeding and hybridization systems, providing highly productive commodity hybrids.

Based on the analysis of literary sources, it was found that when using a two-breed crossed pig in crossbreeding with third-breed boars, the level of heterosis is 86%, which is by 19% higher compared to the two-breed crossbreeding hybrid.

It is advisable to obtain the final hybrid based on the following scheme:

Stage 1 - obtaining a crossbred sow F_1 on the basis of crossing sows of specialized maternal and boars of the first paternal line;

Stage 2 - evaluation and selection of crossed females F_1 for further use in hybridization;

Stage 3 - obtaining the final three-breed hybrid on the basis of crossing sows F_1 and boars of the second paternal line.

The getting hybrid young is intended for fattening in order to obtain the final product.

To introduce the final hybrid into production, it is necessary to evaluate the designed genotypes for combinational compatibility. That is, to evaluate the productivity of sows and replacement young F_1 and young of the final cross in a comparative aspect with the original parental forms (clean specialized lines).

Acknowledgements

The author expresses great gratitude and appreciation for the participation in the work on this article to Anna Pavlovna Grishkova, Dr. of Agricultural Sciences.

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