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Popular Article

Development of specialized sire and dam lines in poultry

Dr. Pushpa[1] and Dr. Vikas Sindhu[2]
[1]Ph.D Scholar, Department of Animal Genetics and Breeding, LUVAS, Hisar, Haryana
[2]MVsc Scholar, Department of Animal Nutrition, LUVAS, Hisar, Haryana
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Abstract

Specialized lines are inbred lines that developed from selection for one or two specific traits. These specific sire and dam lines in a crossbreeding system utilized with a terminal cross that has the ability to improve livestock's genetic makeup. Due to their low cost, these lines are typically utilized in commercial broiler enterprises (Smith, 1964). Additionally, these lines have been utilized effectively for pork production, where the sustainability of the industry primarily depends on lowering the cost per unit of output. Pig breeding objectives in the early 1900s focused on both litter size and growth, and up until 1960, they were primarily based on phenotype. Selecting for traits with low heritability and then further specializing into sire and dam lines was made possible in the late 1980s by advancements in computing technologies and statistical techniques. Through genetic modification of performance traits, there exists a chance of improving the profitability of the pig production system. Breeders often have two strategies to bring about this genetic improvement: selecting superior individuals as parents within breeds and selecting breeds or composite lines to be employed in crossbreeding systems (Clutter, 2010). There are several ways to create inbred lines: parent-offspring inbreeding, full-sib inbreeding, half-sib inbreeding, and double first cousin inbreeding. These lines can be maintained by crossing between the inbred lines. During the developmental process, selection within lines is inefficient in maintaining normal performances and more useful lines will emerge from intensive inbreeding in numerous small groups without regard for within-line selection than from mild inbreeding with selection.

Need for Specialized Sire and Dam Lines:

Performance traits include Production traits (growth rate, feed efficiency and carcass composition) and Reproductive traits (age at puberty, fertility and litter size). Production traits are expressed in market animals as well as animals destined for the breeding herd, determine the efficiency of the system whereas reproductive traits are expressed in all breeding females used as parents in the terminal cross, while these same females contribute half of their genetic merit for production traits to each of their market offspring. As a result, the primary selection objective in dam lines designed to provide females for the maternal

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side of the terminal cross should be increased reproduction performance and production performance of their market offspring. These specialized selection objectives are designed to produce lines that can be advantageously combined in a terminal, static cross. Similarly in broiler industry female parent stocks must produce eggs at reasonably high levels in order to keep chick product cost low.

Assumptions

1. both males and females are selected with equal intensity and have the same generation interval;
2. same selection indices can be applied to both males and females, an assumption which cannot be realized in practice if one of the traits is reproductive performance, unless selection is based on relatives' performance;
3. two traits under selection are uncorrelated;
4. traits are genetically additive, and
5. the population parameters, other than the means, are the same for each line and do not change as a result of selection.

Selection of Egg Type Lines

The suitable age for selecting egg type birds is 10 to 14 weeks where inferior birds are removed from the flocks. The body confirmation and development of structural body parts are given more weightage than body weight in selecting these breeders. The birds from each line are selected separately and most of breeding procedures involve mating of males and females from various lines. The chicks from each line are sexed at day-old age and inaccuracies in sexing may lead to mixing of cockerels with pullets and vice versa. These birds of sexing error should be removed prior to mating. The unwanted males must be removed as early as possible to reduce the cost.

Selection of Meat Type Lines

As there is high correlation between weight of meat type parents and their broiler offsprings at eight weeks of age, their selection preferably is done at this age. The selection pressure required for males is more than that of for females. This does not result in any differences in the effects for next generation as males required are fewer than females.

Two methods for development of specialized sire and dam lines:

Pure-line breeding for development of specialized lines:

Specialized sire and dam lines were developed through unique selection program based on different set of traits for sire and dam lines. Pure line selection is based on information on the

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breeding animal and its relatives within populations. Under this approach, the genetic gain in crossbreds arises from the regression on purebred response. RS and RRS are based on the breeding animal's crossbred information. These crossbred selection (CS) methods have shown their advantage to improve traits with low heritability and large non-additive variation. However, both theoretical and experimental studies showed that neither PLS nor RRS is generally optimal to improve crossbred performance. Both purebred and crossbred information should be weighted appropriately to maximize genetic progress of crossbreds. Crossing of these genetically diverse lines results in gene recombination producing a heterotic effect in progeny for different economic traits. Therefore, intense selection within pure-lines and crossing those genetically diverse lines is the most characteristic feature in broiler breeding program. While practicing the artificial selection, care is taken to minimize the inbreeding, and its related consequences in the population. A control population with the same increment in inbreeding as the selected population may be maintained for comparison and evaluation of the selected population.

a. *Layers*: for layer, main objective is "To obtain maximum number of saleable eggs per hen housed at low feed cost per egg or per kg egg mass and the eggs should have optimal internal and external qualities. Stock should have low mortality and high adaptability to different environments." Layer breeders apply selection to improve over 30 traits important for commercial egg production. Breeders today select for (or at least monitor) the age at sexual maturity, the rate of lay, livability, egg weight, body weight, feed conversion, shell color, shell strength, albumen height, egg inclusions (blood and meat spots), and temperament. The selection strategies to improve egg production include part-time egg production records, persistency of lay, clutch length, FCR/Residual feed consumption (RFC), skeletal problems (osteomalacia and osteoporosis).

b. *Broilers*: for broilers, selection strategies concentrate on rapid growth and carcass traits. The most practiced strategy for broiler pure line selection (PLS) is "selection at commercial weight" which employs selection at a weight that matches the market weight and the age at selection becomes progressively earlier as growth potential increases. The other two strategies are the selection at a commercial age and multi-stage selection. Different breeding and selection technologies at different period of time were employed for the genetic improvement of poultry. Breast muscle weight, meat quality, and FCR are major traits; in addition to these, thrust is also being given on skeletal abnormalities, metabolic disorders and welfare. In developing or maintaining a strain of broilers, geneticists must consider a balance of characteristics related to growth versus reproduction.

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Utilization of these specialized sire and dam lines in commercial layer and broiler enterprises minimizes the production cost and the gene recombination in these crosses produced a heterotic effect in progeny for different economic traits.

(ii) Combined crossbred and purebred selection (CCPS)

Development of synthetic lines using specialized selection program and their utilization through cross-breeding has been the vital tools for the progress made in poultry production. Exhaustive literature suggests that including the information recorded on pure as well as crossbreds in selection criterion helps in the improving response to selection in crossbreds. A combined crossbred and purebred selection (CCPS) method, i.e. using crossbred and purebred information, was proposed to achieve genetic response in crossbred animals. Selection index theory was applied to establish a CCPS index. A straightforward way of combining performance on purebred animals with information from crossbred relatives would be to consider purebred and crossbred performance as the expression of two different traits with a genetic correlation between them. Genetic parameters involving crossbreds cannot generally be derived from purebred parameters. CCPS index combining crossbred and purebred information to maximize genetic response in crossbreds under a two-way crossing system. Crossbreeding exploits both additive and non-additive gene action thereby tends to increase heterozygosity. The resulting crossbreds, therefore, are expected to have uniformity and are least influenced by environmental factors compared to their parent lines. The stocks that complement one another effectively, crossbreeding is the most economical method for combining them.

For the successful crossbreeding program, estimation of crossbreeding parameters and identifying the superior cross combination of lines is essential. A number of experimental designs e.g., diallel cross analysis, three-way cross analysis, analysis of double-cross hybrids, line x tester analysis, North Carolina Designs, recurrent selection, and RRS have been designed to estimate crossbreeding parameters. Of these diallel or partial diallel cross have been most extensively used for estimation of general and specific combining abilities, which have helped in maximizing the genetic gains through identification of best lines and cross combinations. Systems such as RRS are being widely used for evaluations of purebred and crossbreds. Statistical tools continue to evolve and their improvements have been a hallmark of the continued success of genetics applied to animal breeding. Presently, the most efficient selection method employs the BLUP as a statistical tool. The data from different sources *viz.* individual's phenotype data and family information in a pedigree matrix, may be combined and analyzed.

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Advantages of specialized sire and dam lines:

- Use of specialized sire and dam lines in a crossbreeding system involving a terminal cross offers the potential for genetic improvement above that realized with use of a general selection objective.
- With the use of specialized lines, a suitable breeding strategy for the smallholder concept can be developed, which is otherwise complicated.
- Use of specialized breeds or lines, in such a manner in which the reproduction traits are conveyed through the female line while the traits important for the end product are conveyed through the male lines.
- Seed stock producers can improve existing sire and dam lines for their respective role in a crossbreeding system and can develop new specialized lines to fill specific roles in a crossbreeding system by using specialized selection objectives. Improved selection response is expected whenever parental lines are specialized.

Summary and conclusion

Use of specialized sire and dam lines in a crossbreeding system involving a terminal cross for genetic improvement shows superior results as compared to general selection methods. For such a line production one need to implement a terminal cross to identify the breeds or lines with characteristics that will best fulfill the sire and dam line roles in the cross. Further, the quality desired by consumers should be kept in mind by commercial producers in order to insure a market for their animals. Communication between seedstock supplier, commercial producer and pork processor will be essential to design and implement specialized selection objectives that allow the producer to meet these demands in an efficient manner. In the near future, information on molecular genetic markers for quality traits may be added to the selection index or used in two stage selection with the index for development of best sire and dam lines. Further, specialized lines may also be used someday in conjunction with embryo transfer techniques by transferring sire line embryos into dam lines with superior embryo survival.

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