



AVOIDING INBREEDING THROUGH MOLECULAR BIOLOGY: IMPLICATIONS FOR MODERN GENETIC IMPROVEMENT

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Abstract: Molecular biology provides modern tools to control inbreeding and preserve genetic diversity in livestock populations. Techniques such as DNA markers, genomic selection, and molecular genetic analyses improve breeding decisions, animal productivity, disease resistance, and overall population health. These approaches support sustainable livestock breeding programs, although economic costs, technical limitations, and the need for specialized expertise still affect their large-scale implementation and practical application.

• Introduction

- Inbreeding reduces genetic diversity and may increase hereditary disorders in livestock populations;
- Sustainable breeding programs require accurate evaluation of genetic relationships between animals;
- Molecular biology allows breeders to analyze DNA-level variation more precisely than traditional pedigree methods;
- Modern molecular tools support healthier and more productive livestock populations.

• Inbreeding in livestock breeding programs

- Inbreeding occurs when closely related animals are mated;
- Excessive inbreeding can reduce fertility, growth, immunity, and productivity;
- Loss of genetic diversity may increase susceptibility to diseases;
- Traditional pedigree analysis has limitations in detecting hidden relatedness.

• Molecular biology tools used in genetic improvement

- DNA markers help identify genetic similarities between animals;
- Genomic selection improves breeding accuracy using genome-wide information;
- Molecular techniques allow early detection of harmful genetic variants;
- Genetic testing supports better mating strategies and population management.

• Advantages of molecular approaches

- More precise estimation of genetic relationships;
- Reduction of inbreeding rates in breeding populations;
- Improved animal health and long-term genetic stability;
- Increased productivity and breeding efficiency.

• Limitations and challenges

- High costs of molecular testing and genomic technologies;
- Need for specialized laboratories and trained staff;
- Difficulties in integrating molecular data with traditional performance traits;
- Limited accessibility for small-scale breeding systems.

• Conclusions

- Molecular biology is an important tool for controlling inbreeding in livestock populations;
- Genomic technologies improve breeding decisions and preserve genetic diversity;
- Balanced integration of molecular and traditional breeding methods is essential;
- Continued technological development may increase accessibility and efficiency in the future.