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Building Better Herds: A Species-Wise Account of Genetic Improvement in Indian Livestock

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Abstract

India's livestock breeding programmes have evolved from localized crossbreeding experiments to a scientifically driven national genetic improvement system covering cattle, buffalo, sheep, goats, pigs, and poultry. Advances in quantitative genetics, including breeding value, heritability, progeny testing, and more recently genomic breeding values, have transformed animal selection and accelerated genetic progress. Home to the world's largest livestock population, India ranks first in milk production, supported by landmark initiatives such as the Key Village Scheme, Intensive Cattle Development Programme, Operation Flood, the National Programme for Bovine Breeding and Dairy Development, and the Rashtriya Gokul Mission. Recent developments, including the National Digital Livestock Mission and indigenous genomic tools such as INDUSCHIP, BUFFCHIP, GAUCHIP, and MAHISHCHIP, have further strengthened precision breeding and reduced dependence on imported technologies. Despite these achievements, challenges remain, particularly the declining indigenous cattle population, lower productivity compared with global standards, and limited genetic improvement programmes for small ruminants, pigs, and poultry. Future breeding strategies should integrate genomic technologies with conservation of indigenous genetic resources to achieve sustainable and climate resilient livestock improvement.

Keywords: Genetic improvement, Genomic selection, Heritability, Rashtriya Gokul Mission, National Livestock Mission.

1. Introduction

Genetic improvement aims to enhance the genetic merit of livestock populations by selecting animals with superior performance and using planned mating strategies to improve economically important traits over successive generations. Grounded in the principles of quantitative genetics established by Fisher (1918) and later translated into practical breeding by Lush (1937), modern breeding programmes now integrate molecular and genomic technologies to accelerate genetic gain. In India, however, genetic improvement has always

required a careful balance between increasing productivity to meet growing demand and conserving the country's rich indigenous livestock diversity.

2. Core Concepts Underlying Genetic Improvement

The breeding value of an animal is the value judged by the mean performance of its progeny, reflecting the additive genetic effects it transmits to offspring, as distinct from dominance and epistatic effects that are not reliably passed on. Estimation of breeding value, historically through progeny testing (evaluating a sire based on the recorded performance of his daughters), forms the backbone of dairy cattle and buffalo improvement programmes in India. Heritability and selection response: Heritability (h^2), the proportion of phenotypic variance attributable to additive genetic variance, determines how effectively selection on phenotype translates into genetic gain across generations.

Genomic selection has become an established tool for identifying high-potential animals at an early age based on GBVs, offering a more accurate approach than traditional phenotype-based assessment, since it evaluates an animal's genetic merit directly from its DNA rather than waiting years for progeny records.

These remain foundational methods, now increasingly supplemented rather than replaced by genomic tools; young bull calves of breeds such as Gir, Sahiwal, Kankrej, Holstein-Friesian crossbred, Jersey crossbred cattle, and Murrah and Mehsana buffalo are currently selected based on GBV under combined progeny testing and genomic selection projects.

3. Species-Wise Genetic Improvement

3.1 Cattle

Genetic improvement of cattle in India has relied on a combination of crossbreeding and systematic within-breed selection of both indigenous and crossbred populations. Progeny testing, pedigree selection, and performance recording programmes led by institutions such as ICAR–National Dairy Research Institute (NDRI) and the National Dairy Development Board (NDDB) have produced genetically superior bulls for crossbred populations, including Karan Fries and Karan Swiss, as well as elite indigenous breeds such as Gir, Sahiwal, and Kankrej. In recent years, breeding programmes have entered the genomic era with the development of indigenous genotyping platforms, including INDUSCHIP and the unified GAUCHIP, under the National Bovine Genomic Centre for Indigenous Breeds established through the Rashtriya Gokul Mission. The programme aims to genotype more than 71,000 milk recorded animals to accelerate genomic selection. According to the 20th Livestock Census (2019), India had

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192.49 million cattle, representing nearly one fifth of the global cattle population, with about 83% comprising indigenous or non descript cattle. While approximately 51 million animals are exotic or crossbred, indigenous cattle continue to form the backbone of the national herd. Supported by sustained genetic improvement programmes, India has maintained its position as the world's largest milk producer, with milk production reaching 247.87 million tonnes in 2024–25.

3.2 Buffalo

Unlike cattle, genetic improvement in buffalo has primarily relied on within-breed selection, particularly in Murrah and Mehsana, as no exotic buffalo breed surpasses the production potential of Indian buffaloes. Traditional progeny testing has recently been complemented by genomic selection through the development of the indigenous MAHISHCHIP genotyping platform by NDDB in collaboration with ICAR-NBAGR, NIAB, and BAIF. According to the 20th Livestock Census (2019), India had 109.85 million buffaloes, representing nearly 60% of the global buffalo population. The population increased by about 1.1% over the previous census, with Uttar Pradesh accounting for the largest share, highlighting the pivotal role of buffaloes in India's dairy sector.

3.3 Sheep

Genetic improvement of sheep in India has combined selective breeding of indigenous breeds with limited, targeted crossbreeding for specific traits, coordinated primarily through the All India Coordinated Research Project on Sheep for Wool at CSWRI, Avikanagar. Synthetic breeds such as Bharat Merino, Kashmir Merino, Hissardale, and the meat-type Avimaans (Dorset/Suffolk × Malpura/Sonadi) represent applied outcomes of breeding-value-based sire selection combined with planned crosses. Sheep accounted for about 13.87% of the total livestock population as per the 20th Livestock Census (2019), with an increase of 14.1% over the previous census; Telangana recorded the largest state-wise sheep population. India ranks third in the world in sheep population.

3.4 Goat

Genetic improvement of goats has combined selection within prolific indigenous breeds (Barbari, Black Bengal, Jamunapari, Sirohi) with structured crossbreeding trials (Beetal × Alpine/Saanen) under AICRP on Goats. India maintains 28 recognized indigenous goat breeds, reflecting one of the richest goat genetic resource bases globally.

Statistics: Goats accounted for about 27.80% of total livestock population in the 20th Livestock Census (2019), registering a 10.1% increase over the previous census; Rajasthan

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recorded the largest state-wise goat population. World ranking: India ranks second in the world in goat population.

4. Government Schemes and Policies

Year	Scheme/Policy	Focus
1950s	Key Village Scheme	Upgrading nondescript cattle using superior breeds
1963	Indo-Swiss Project, Kerala	Cattle crossbreeding, first deep-frozen semen technology in India
1964	Intensive Cattle Development Projects	Nationwide AI-based cattle improvement
1969	Crossbreeding as official national dairy policy	Fourth Five-Year Plan endorsement
1970	Operation Flood (NDDB)	Dairy cooperative expansion and AI infrastructure
2013	National Livestock Policy; National Programme for Bovine Breeding and Dairy Development	Balanced productivity and indigenous conservation focus
2014	Rashtriya Gokul Mission (RGM) launched	Conservation and genetic upgradation of indigenous bovines
2016	E-Pashu Haat Portal launched	Digital linking of breeders and farmers for germplasm trade
2017	National Bovine Genomic Centre for Indigenous Breeds (NBGC-IB) established	Genomic selection for indigenous cattle/buffalo bulls
2021	RGM restructured (2021-22 to 2025-26); National Digital Livestock Mission (NDLM) unveiled	₹2,400 crore outlay; digital livestock ecosystem
2021	National Gopal Ratna Award instituted	Recognizing indigenous breed conservation efforts

2015

2022-23	National Livestock Mission (NLM) sub-missions	Breed development of poultry, sheep, goat, and piggery; entrepreneurship support
2025	RGM outlay enhanced to ₹3,400 crore	Continued genomic selection, sex-sorted semen, and IVF scale-up

Under the revised RGM, components now include the bull production programme (progeny testing, pedigree selection, genomic selection, germplasm import), advanced reproductive technologies (sex-sorted semen with a targeted female-to-male calf ratio of not less than 90:10, IVF/MOET), and Gokul Grams permitting up to 40% non-descript animals for integrated indigenous development.

5. conclusion and Challenges

Despite these achievements, India's average milk yield per animal remains below that of leading dairy nations, highlighting the need to improve genetic merit rather than simply increase livestock numbers. Genetic improvement programmes for sheep, goats, pigs, and poultry also remain less developed than those for cattle and buffalo. Expanding genomic selection, strengthening the National Digital Livestock Mission, and integrating genomic information into national breeding programmes will be essential for enhancing productivity while conserving India's rich livestock genetic diversity.

References

Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India. (2024). *Animal Husbandry Statistics (AHS)*. https://dahd.gov.in/en/schemes/programmes/animal-husbandry-statistics

Ensure IAS. (2025, August 12). *Basic Animal Husbandry Statistics (BAHS) 2024*. https://www.ensureias.com/blog/current-affairs/basic-animal-husbandry-statistics-bahs-2024

Falconer, D. S., & Mackay, T. F. C. (1996). *Introduction to quantitative genetics* (4th ed.). Longman.

Fisher, R. A. (1918). The correlation between relatives on the supposition of Mendelian inheritance. *Transactions of the Royal Society of Edinburgh*, *52*(2), 399–433.

Krishi Jagran. (n.d.). *Rashtriya Gokul Mission: Know how livestock farmers can take benefit of this government scheme*. https://krishijagran.com/animal-husbandry/rashtriya-gokul-mission-know-how-livestock-farmers-can-take-benefit-of-this-government-scheme/

Krishinetra. (2024). *Livestock development schemes and statistics in India*. *Krishinetra Journal*, *2*(6). https://krishinetra.com/june2024/002.pdf

Lush, J. L. (1937). *Animal breeding plans*. Iowa State College Press.

National Dairy Development Board. (2025). *Implementation of genomic selection in cattle and buffalo*. https://beta.nddb.coop/services/animal-breeding/implementation-of-genomic-selection-in-cattle-and-buffalo/

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PIB. (2025). *Census for cows, buffaloes, goats and sheeps* [Press release]. Press Information Bureau. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2205263&reg=3&lang=2

Sharma, A., et al. (2022). Livestock population trend analysis in India. *Agricultural Reviews*. https://arccjournals.com/journal/agricultural-reviews/R-2711

United States Department of Agriculture, Foreign Agricultural Service. (2023).