THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
Jan, 2025 Vol.5(1), 6071−6081

Review Article

Optimized breeding of small ruminants across India's different agro climatic zones; current trends and prospects

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DOI:10.5281/ScienceWorld.14759633

Abstract

Small ruminants play an important role in rural economy of India especially for small and marginal farmers. A goat is rightly called as a poor man's cow and sheep contributes immensely in the dry cold and temperate region of the country. Though, these species of livestock seldom find place in policy making. Since the sixth five-year plan (1980-85), where states have been directed to develop livestock policy, all the efforts have been concentrated on bovines. The current review sheds insight on the nation's small ruminant breed improvement initiatives, both before and after independence. It also highlights the breeding policy in different agro climatic zones of the country and discusses the gaps so far. The review emphasizes on a strong need for renewal of the small ruminant region wise breeding policy taking into consideration the newly emerged breeds of sheep and goat registered.

Key words- sheep, goat, breed, breed improvement program, breeding policy.

Introduction

Small ruminant breeding in different agro-climatic zones of India is a topic of significant importance due to the diverse environmental conditions present in the country and the need to ensure sustainable livestock production. Local breeds of small ruminants, known for their adaptability to specific climatic conditions, have been found to exhibit better tolerance to local climates compared to imported breeds (Katsarou *et al*., 2022). This adaptability is crucial in ensuring the resilience of small ruminants in the face of changing environmental conditions, such as those brought about by climate change. Studies have shown that indigenous goat breeds like Malabari and Salem Black goats, which are native to humid tropical agro-climatic zones, demonstrate superior adaptability to heat stress, highlighting the importance of considering local breeds in breeding programs (Pragna *et al*., 2018).

Genetic improvement plays a vital role in developing small ruminants that are well-suited to diverse environmental conditions. Breeding strategies that take into account the specific agroecological contexts can lead to the production of animals that thrive in varying climates and

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farming systems (Phocas *et al*., 2016). Community-based livestock breeding programs have emerged as a promising approach to implementing breeding initiatives that cater to the needs of smallholder farmers, particularly in regions with diverse agro-climatic conditions (Kaumbata *et al*., 2021).

Small ruminants are not only important for livestock production but also serve as reservoirs for zoonotic diseases like brucellosis and coxiellosis, which pose public health threats in India (Leahy *et al*., 2020). Selective breeding for traits such as trypanotolerance can offer solutions for enhancing small ruminant production systems, especially in low-input agricultural settings (Malatji, 2022). Furthermore, breeding small ruminants for resistance to gastrointestinal nematodes can contribute to improving overall health and productivity in small ruminant populations (Saddiqi *et al*., 2011).

Livestock genetic variability is essential for ecosystem conservation and climate change mitigation, making the genetic improvement of small ruminants a critical aspect of sustainable livestock management (Negro *et al*., 2022). The utilization of sensing solutions and technological advancements in small ruminant breeding can enhance performance, health, and overall well-being of animals, contributing to more efficient breeding programs (Caja *et al*., 2020). Moreover, the integration of indigenous knowledge in community-based breeding programs can lead to resilient livestock development, particularly in regions with diverse agro-climatic conditions (Hemachand, 2023).

India ranks second in sheep population (possesses more than 4.03% of the world sheep population) (FAOSTAT, 2019). There are 74.26 million sheep in India (20th Livestock Census). From post-independence 1951 (39.10 million) till the 2019 livestock census (74.26 million) the sheep population has amplified by 89 %. There had been a constant augmentation in the number of sheep and goats in the country since the 16th Livestock census with an exception in 2012 (19th livestock census) where a marked fall in the population of both species was evident for which the reasons have been studied extensively. (Bhardwaj *et al*., 2018; Shinde and Sejian. 2013)

There had been an increase in number of registered breeds in India after 2002. Kaura in 1943 reported 15 recognized goat breeds which were later on reported to be 20 (Acharya, 1982). The number of breeds of goat was considered 20 for several years until in 2003 long hair breeds like Bakharwal and Kangam from state of Kashmir and Himchal Pradesh respectively were added to the list. Approximately the same time, Katchi/Kathiwadi goat was registered making the goat breed count to 23. Presently India has 39 registered breeds of goat.

Similarly, the first attempt to characterize and identify the sheep breeds of India was made by Acharya, 1982 who reported them to be 40 until in 2012-13 Garole and then Kendrapada were added to the list to make it to 42 and then Panchali in 2018 and Kajali in 2020 to make the number to 44. In Dec 2023 Macherla breed of Andhra Pradesh was recognized and so the number of sheep breeds in the

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country is 45 now. According to the FAO World Watch List (2000), there are 60 breeds of sheep in India.

Efforts were made to classify sheep and goat breeds on the basis of their geographical distribution, phenotypes and production performance (Kaura 1941, 1942, 1943, Lal 1947, Mishra *et al.* 1970, Acharya and Arora 1978, Acharya 1982). Presently these breeds have been classified based on their utility as well as agro ecological regions (Aggarwal, *et.al.* 2022). Indian goat breeds are classified based on their utility as meat, fibre and milk.

Breed improvement program

Breeding of small ruminants has been carried out through ancient times Kautilya's Arthashastra mentioned proper management of not only cow, buffalo, camel but also for sheep and goat herds. (Kautilya, 1956). The medical science and the husbandry practices along with disease prevention strategies have been documented to be well developed (Chakraborty, 2023), however there is scarce documentation of planned breeding in ancient India. Breed improvement program in India were initiated by East India Company during pre-independence era. However, these efforts were more concentrated on crossbreeding specially the sheep. The first scientific evidence and outcome of breed improvement program was development of Hissardale breed in 1930 by cross breeding of Bikaneri ewes with Australian Merino rams at Government Livestock Farm Hissar (Rather *et al.*, 2020). Crossbreeding experiments were initiated in 19th century by the East India Company using Cape Merino (Rather *et al.*, 2020) and Southdown (NCA, 1976). Crossbreeding trials were conducted from 1938 to 1949 for sheep improvement in the country (Jain *et al.*, 1998).

The year 1962 marks a major milestone in sheep improvement as Central Sheep and Wool Research Institute (CSWRI) was established. This ICAR institute has developed many crosses *viz*., Bharat Merino (Chokla, Nali x Rambouillet, Merino with 75% exotic inheritance), Avivastra (Chokla, Nali x Rambouillet, Merino with 50% exotic inheritance), Avikalin (Malpura x Rambouillet with 50% exotic inheritance), Avimannas (Malpura, Sonadi x Dorset, Suffolk with 50% exotic inheritance) and Indian Karakul (Marwari, Malpura, Sonadi x Karakul with 75% exotic inheritance) (Bhateshwar *et al*. 2022) with good performance.

Central Institute for Research on Goats (CIRG), Makhdoom, Uttar Pradesh was established in the year 1976 which is approximately 14 years after the establishment of CSWRI. The institute has a research station and nucleus farms for Barbari and Jamnapari goats (cirg.res.in). Besides the units for Jakrana and Muzzafarnagri sheep are also present in the institute. It is a major coordinator for goat AICRP, twelve breeds are covered through fourteen centers across the country, coordinated by CIRG, Makhdoom.

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All India Coordinated Research Project (AICRPs) was implemented in 1971 which stands a vital step towards utility-based improvement of indigenous breeds in India. Breed improvement and conservation programmes of different goat breeds under field condition were launched under the AICRP on goats by establishing several field units of different goat breeds of India (Swarup and Singh, 2011). Some preliminary work on ex situ conservation of goat genetic resources has already been started at CIRG, Mathura, India. The breeds covered in this program were mainly Jamunapari and Barbari goats. AICRP centers were established for milk production, meat production and mohair production of goats. Centers were established at National Dairy Research Institute (NDRI), Karnal and Kerala Agricultural University, Trichur for milk production. For improvement in meat production, centers were established at CSWRI, Avikanagar, Bisra Agricultural University, Bihar, Assam Agricultural University, Assam and Animal Husbandry department, Sikim. Mohair centers were established at Mahatma Phule Krishi Vidyapeeth, Rahuri, Animal Husbandry department, Upashi, Jammu and Kashmir and Indian Veterinary Research Institute, Mukteshwar. (https://pcgoatcirg.icar.gov.in/home/aicrp_origin)

Sheep-breeding work under AICRP was undertaken for fine wool improvement, this project involved breeding of exotic fine-wool breeds (Soviet Merino and Rambouillet) with indigenous breeds (Gaddi, Nali, Chokla, Patanwadi, Nilgiri and Bonpala). Cross-breeding experiments were also carried out for improving mutton breeds by crossing exotic mutton breeds like Suffolk and Dorset with indigenous breeds like Muzzafarnagri, Malpura, Sonadi, Deccani, Mandya and Nellore. AICRP centers of CSWRI, Bikaner, CIRG, Makhdoom, MPKV, Rahuri and SVVU, Palamner were later on merged under Network Project on Sheep Improvement (NWPSI) in 1990 (http://www.cswri.res.in/network_project_on_sheep_improvement.asp). Breeds involved in NWPSI were Marwari, Muzaffarnagri, Deccani, Nellore, Madras Red and Magra. Nimbkar Agricultural Research Institute (NARI), located in Phaltan, Maharashtra, established its Animal Husbandry unit in 1990, launched NARI Suwarna sheep breed developed by introducing ‘FecB’ or Booroola gene from the Garole sheep into the local Lonand Deccani sheep (Tejaswi, *et al*., 2016).

National Livestock Mission (NLM) in 2017 proposed Innovative project for Genetic Improvement of Sheep and Goat (GISG) under sub mission of Livestock Development. Sirohi, Jhakrana, Beetal, Jamnapari and Kutchi were the meat purpose and Mehsana, Surti, Jhakrana, and Beetal were the milch purpose high genetic merit breeds of goat selected for breeding under this project. Similarly, Deccani, Mecheri, Chokla, Mandya and Gaddi; the meat purpose high genetic merit sheep breeds were a part of the project. The project is implemented in two steps. GISG scheme involved, identification of good performing animals, breeding of the best to the best, distribution of

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procured male kids for natural service and in semen labs (Innovative project for Genetic Improvement of Sheep and Goat 2017).

NLM is presently instrumental in employment generation through entrepreneurship development in small ruminant and provides 50% subsidy to the sheep/goat farm unit of minimum 500 females + 25 males. Central government provides funds to State Animal Husbandry Department through NLM for establishment of Frozen semen labs for small ruminants (nlm.udyamimitra.in). National Action Plan (NAP) 2022 was formulated separately for both the species as NAP sheep and NAP goat in 2018. The plan proposed a four-step action plan; pure line high genetic merit breeding for native superior breeds, hybrid high genetic merit breeding for native average breeds, hybrid of low genetic merit non-descript (ND) breed with high genetic identified breed for ND and use of exotic germ plasm of suitable traits for higher meat, milk and wool production (NAP sheep and NAP goat).

Breeding policy

In the sixth five-year plan (1980-85), states were directed to frame breeding policies (table 1) or guidelines for breeding of livestock that would suite their respective agro climatic precinct. Of all the states of India, twelve states formulated directives for small ruminant breeding in their livestock breeding policy. State of Assam (2019), Andhra Pradesh (2023), Himachal Pradesh (2018), Rajasthan (2010) and West Bengal (2023) independently formulated their breeding plan for sheep and/or goat breeding. Silent features of small ruminants breeding policy in different states are discussed herein.

Table 1. Detail of Livestock breeding policy of different states.

State	Year of formulation	Cattle and Buffalo	Sheep and Goat	Pig and Poultry	The policy
Karnataka	2010 2015*	Yes	No	No	Karnataka Cattle and Buffalo breeding policy 2015
Jharkhand	2011	Yes	Yes	Yes	Jharkhand livestock breeding policy 2011
Kerala	2018	Yes	Yes	No	State Breeding policy 2018
Jammu and Kashmir (incl Ladakh)	2019	Yes	Yes	Yes	J& K State Breeding policy 2019
Madhya Pradesh	2001	Yes	Yes	No	Madhya Pradesh State Breeding policy 2001
Manipur	2004	Yes	No	No	Manipur State Breeding policy 2004
Meghalaya	2018	Yes	No	No	Meghalaya State Breeding policy 2018
Odisha	2015	Yes	No	No	Odisha Bovine Breeding policy2015
Punjab	2012	Yes	No	No	Punjab Livestock Breeding policy 1012

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Rajasthan	2014-2015	Yes	No	No	Rajasthan Cattle and Buffalo Breeding policy 2014-15
Arunachal Pradesh	2005 2008	Yes	Yes	Yes	Yak and Mithun Livestock and Poultry Breeding policy of AP 2008
Assam	2002	Yes	Yes	Yes	Assam State Livestock Breeding policy 2002
Bihar	2005 2011*	Yes	Yes	Yes	Bihar Pashu Prajanan neeti 2011
Haryana	2018	Yes	No	No	Haryana Bovine Breeding Policy 2018
Maharashtra	2008 2010*	Yes	Yes	Yes	Maharashtra State livestock policy 2010
Chhattisgarh	2008	Yes	Yes	Yes	Chhattisgarh livestock development and Breeding policy 2008
Tripura	2021	Yes	Yes	Yes	Tripura State Livestock and Breeding policy 2021
Andhra Pradesh	2005	Yes	No	No	Breeding policy for Cattle and Buffalo in Andhra Pradesh
Goa	2010 2015* 2020*	Yes	Yes	No	Breeding policy for Cattle and Buffalo for State of Goa
Gujarat	2013 2018*	Yes	No	No	Gujarat State Livestock Breeding policy 2018
Sikkim	2006	Yes	No	No	Cattle Breeding policy for state of Sikkim 2006
Tamil Nadu	2008	Yes	No	No	Breeding Policy for Cattle and Buffalo in Tamil Nadu 2018
Uttar Pradesh	2018	Yes	No	No	Uttar Pradesh Pashu Prajanan neeti 2018
West Bengal	2002 2007*	Yes	No	No	Cattle and Buffalo Breeding policy for West Bengal
Uttarakhand	2005	Yes	Yes	Yes	Uttarakhand Pashu Prajanan neeti 2005

**Renewed* (Source- https://dairyknowledge.in/dkp/section/state-breeding-policy)

Table 2. Silent features of sheep breeding in different agro-climatic zones of India

Region	States	Utility	Breeding Policy
Temperate Himalayan region	Jammu and Kashmir, Himachal Pradesh and hilly regions of Uttaranchal	Wool/ Apparel type	Kashmir Merino to be maintained with 75% exotic inheritance (CB). Selective breeding for Gaddi and Rampur Bush hair.
North Western arid	Punjab, Haryana, Rajasthan, Gujarat, plains of Uttar Pradesh and Madhya Pradesh	Carpet wool type	Selective breeding of Native and up gradation of non-descript with Chokla,

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and semi-arid region			Nali, Malpura, Sonadi. CB strictly prohibited in Gujarat and Rajasthan.
Southern Peninsular Region	Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Kerala	Coarse wool with meat type	Selective breeding of Native and Up gradation of non-descript with the native of respective pockets.
Eastern Region	Bihar, Jharkhand, West Bengal, Orissa, Assam, Meghalaya, Arunachal Pradesh, Mizoram, Manipur, Tripura, Nagaland and Sikkim	Meat/ Wool	Selective breeding for natives and Up gradation with Mujjafarnagri and Chhotanagpuri (Jharkhand)

Table 3. Silent features of goat breeding in different agro-climatic zones of India

Region	States	Utility	Breeding Policy
Temperate Himalayan region	Jammu and Kashmir, Himachal Pradesh and hilly regions of Uttaranchal	Pashmina and Meat	Selective breeding for local goats. Bhakarwali and Beetal for up gradation. Swiss Alpine (milk) and Angora goats (pashmina) for crossbreeding.
Dry Northern region	Punjab, Haryana, Rajasthan, Uttar Pradesh and plains of Uttaranchal	Milk and Meat	Selective breeding of Native and up gradation of non-descript with Jamnapari, Beetal and Berari.
Central region	Madhya Pradesh, Gujarat and parts of Rajasthan	Milk and Meat	Selective breeding of Native and up gradation of non-descript with Sirohi, Barbari, Jamnapari. In Gujarat up gradation of non-descript with the native of respective pockets.
Southern Peninsular Region	Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Kerala	Meat	Selective breeding of Native and Up gradation of non-descript Osmanabadi, Malabar and Beetal
Eastern Region	Bihar, Jharkhand, West Bengal, Orissa, Assam, Meghalaya, Arunachal Pradesh, Manipur, Tripura, Nagaland and Sikkim	Meat also fibre (Sumi-Ne) and skin (Black Bengal)	Selective breeding of Natives and up gradation by use of Black Bengal and Beetal

Challenges for small animal breeding in India

In spite of being the richest source of protein and owning the ability to be maintained at zero input husbandry practices, the small ruminant industry is inclined to many challenges like absence of involvement of all stakeholders, absence of stake holder centric breeding objectives variable market price and the most important is lack of linkage between market and producers. In the agrarian economy like India, during marketing of these animals' weight of the animal is seldom given importance but the

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number (Gowane *et al*., 2019). Government schemes implemented must be designed to be self-sustaining models involving stakeholders. The livestock keepers often prefer to sale the healthiest and sturdy animals of the herd to fetch more money leaving behind the weaker animals to breed lacking space for genetic improvement and creating scarcity of good breeding stock. Other challenges include absence of public private partnership, lack of value addition such as meat processing, warehousing, cold storage, refrigerated vehicles, etc. the threats in small ruminant industry include climate change, invasion of diseases, depletion of pasture land and increased urbanization (https://dahd.nic.in/sites/default/filess/NAP%20on%20Goat.pdf). Uncontrolled mating is practiced throughout the flocks and hence together with small flock sizes and poor/absence of record keeping on pedigree always results in inbreeding in the flock leading to poor growth rates (Saico and Abul, 2007).

Gaps

India is a rich deposit of biodiversity and hence is a home to many breeds of AnGR. The breed calendar especially for goats has increased by one and half fold compared to the last decade. There had also been an addition in number of sheep breeds making a count of 39 and 45 registered breeds of goat and sheep, respectively in the country. Though, small ruminants seldom form a part of policy making is an important issue to be addressed. Accommodating these new breeds is a new challenge.

The newly recognized breeds do not have a place in the policy already in operation. With the initiation of Mission Zero Non-descript, we expect more breeds of livestock to be registered in near future. These are the animals we have been considering as ND for decades. With upcoming of new recognized breeds, the breeding policy will need amendment too. Livestock breeding policies in majority of the states are designed long back and have not been renewed in last two decades.

Rigid breeding policy for breeding of all species of livestock must be formulated and implemented by the states taking into consideration different pockets of agroclimatic zones. Before formulating a breeding policy for up gradation of ND, an attempt must be made to classify similar phenotype/genotype group or geographically isolated population as a well-recognized breed.

Considerations in proposing the breeding policy

Classification and characterization of non-descript population would be the first step before up gradation of such population. Emphasis must be given on selective breeding of native breeds and provisions be made for breeding and supply of high genetic merit rams and bucks of indigenous breeds. Breed wise survey is must along with the census survey if we aim to design a flawless policy focused on genetic improvement.

Breeding schemes can be implemented at three levels; Government level, Institution level and village/grass root level. Semen stations for semen dissemination of native breeds of small ruminants

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needs to be established at government level. Research institutes and breeding stations can maintain an elite nucleus for renowned breed of the respective area and an Open Nucleus Breeding (ONB) scheme can be implemented involving the progressive farmers. At grass root level, group breeding scheme can be implemented making a group of 8-10 livestock owners. Exchange of high genetic merit rams and bucks to avoid inbreeding can be brought about.

Species specific, region specific rigid breeding policy needs to be formulated by the sates taking into consideration the climate of the area and the need of the inhabitants. General tendency of livestock owners to sacrifice the high genetic merit good producing animals and breeding the scrub left in the flock needs to be worked on. Non availability of high genetic merit bucks/rams/semen is a major hindrance in genetic improvement of livestock in the country.

Future Prospects in small ruminant breeding

While formulating the breeding policy it is very important to consider various agro-climatic and socio-economic aspects along with the constraints in production system of the small ruminants. The most sustainable program for genetic improvement of small ruminants would be community-based selective breeding program for the indigenous breeds. Community ‑ based breeding program (CBBP) has shown to be self ‑ sustainable (Mueller *et al*., 2015) and such models can be implemented to assure the participation of stake holders along with the genetic improvement of the breed. Private institutions, breeding societies and NGOs must take a step in respective area to formulate and implement such program.

A classic example of community based conservation of sheep breed is propagation of a prolific FecB gene carrier "NARI Suwarna" by Nimbkar Agricultural Research Institute (NARI) in Maharashtra State of India. Another example is 'goat bank', an innovative initiative fostering self-reliance. A genetic component for improvement of germplasm must be integrated in the concept of goat bank which will lead to more fruitful results.

Use of information technology in breeding will help in maintenance of records and hence help in decision making for selection of animals. Recently, a web-based platform for sheep (SDBMS, 2018) and goat (GMIS, 2018) database management system has been developed in India for collection of data related to all aspects of production system in small ruminants. (Govane *et al*., 2019). Such software can be used for data recording and decision making.

Conclusion

Small ruminants are the back bone of Indian economy. With increase in the population of sheep and goat as well as scientific knowledge about their rearing there has been an increase in number of registered breeds for both the species specially goat. The breeding/ guiding policy formulated for

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breeding of small ruminants needs serious revision and strict implementation. ONB and CBBP scheme is a potent self-sustainable solution to bring about the genetic gain in native breeds of small ruminants.

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Published 29/01/2025