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Goat Breeding Strategies for Enhanced Productivity



ICAR-Central Institute for Research on Goats

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Goat Breeding Strategies for Enhanced Productivity

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PREFACE

Goat farming plays a significant role in the socio-economic fabric of India, especially in rural areas, where it provides livelihoods to millions of people and contributes to food security and poverty alleviation. However, the diversity of goat breeds in India is under threat due to various factors such as indiscriminate breeding, habitat loss, and lack of focused breeding strategies. Recognizing the importance of sustainable management of goat diversity, this policy paper presents a comprehensive framework for the improvement of goat breeding strategies in India.

The aim of this policy paper is to provide a roadmap for enhancing the genetic potential, productivity, and marketability of Indian goat breeds while preserving their unique adaptability and resilience. The paper emphasizes the need for tailored breeding strategies that take into account the specific characteristics of each breed, as well as the importance of community-based approaches and research support. Through this policy paper, we hope to stimulate dialogue and collaboration among stakeholders including policymakers, researchers, farmers, and breeders, towards the development and implementation of effective goat breeding strategies. By working together, we can ensure the long-term sustainability and viability of goat farming in India, while also preserving our rich goat genetic resources for future generations.

Authors

Goat Breeding Strategies for Enhanced Productivity

Introduction

Goat farming has long been an integral part of India's agricultural landscape, contributing significantly to rural livelihoods, food security, and economic growth. With a diverse array of indigenous goat breeds adapted to various agro-climatic conditions, India boasts one of the world's richest goat genetic resources. However, despite their importance, indigenous goat populations face numerous challenges, including inadequate productivity, breed dilution, genetic erosion, and limited access to modern breeding practices. Recognizing the critical role of goat farming in supporting the livelihoods of millions of smallholder farmers and pastoral communities, as well as its potential contribution to sustainable agriculture and rural development, there is an urgent need for comprehensive goat breeding strategies. These strategies must prioritize the conservation of genetic diversity, enhance productivity, and ensure the resilience of goat populations to emerging challenges such as climate change and disease outbreaks.

This policy paper aims to outline a set of holistic goat breeding strategies tailored to the Indian context, emphasizing the suitable genetic improvement, conservation of indigenous goat breeds while enhancing their productivity and market competitiveness. The authors have also drawn attention towards the health, nutritional, reproduction issues including artificial insemination and marketing aspects for the enhanced productivity. Drawing upon insights from scientific research, best practices in goat breeding, and stakeholder consultations, these strategies seek to address the multifaceted challenges facing the goat farming sector and pave the way for its sustainable development. Key focus areas include the promotion of region-specific breeding programmes, the establishment of nucleus breeding farms, the integration of modern breeding techniques, capacity building for farmers and extension workers, and the strengthening of market linkages. By adopting a participatory and inclusive approach, involving government agencies, research institutions, private sector stakeholders, and local communities, these strategies aim to harness the full potential of India's diverse goat genetic resources for the benefit of present and future generations.

Overview of the Goat Sector in India

Socio-economic Contribution of Goat in India

Goat farming plays a significant role in the socio-economic landscape of India, particularly in rural areas. It is estimated that approximately 33.2 million rural households, constituting 24% of the total livestock farmers, are involved in goat husbandry. Interestingly, farmers with less than 2.0 hectares of land, categorized as marginal and small farmers, are the custodians of over 76% of the nation's total goat population. Goat farming offers several distinct economic and managerial advantages compared to other livestock species. These include lower initial investment requirements, minimal input demands, heightened prolificacy, an extended breeding season, and a preference for grazing on a wide array of plants. Additionally, goats exhibit early sexual maturity, improved efficiency in digesting crude fibre from low-grade roughages, ease of handling, and year-round market availability. They also demonstrate enhanced adaptability to climatic stressors. In the livelihoods of rural communities, goats fulfill multiple roles, such as generate income, provide employment opportunities, offer nutritional sustenance, enhance security, aid crop production through manure provision, facilitate the acquisition of critical agricultural inputs, and serve as a buffer against crop failures, especially in climatically and economically disadvantaged regions (Chatli e*t al.,* 2023; Singh e*t al.,* 2013b). There is a growing reliance on goat farming as a means of socio-economic upliftment, particularly among landless individuals and women. Due to their superior physical and physiological adaptability attributes, goats emerge as the preferred livestock option in drought-prone areas, experiencing less susceptibility to drought compared to other livestock species. In mixed-species grazing systems prevalent in rural India, goats play a crucial role by consuming plants less preferred by other livestock species, thereby adding flexibility to overall livestock management strategies. Moreover, goats can be seamlessly integrated with other livestock species, crops, and perennial trees. The future outlook for the goat industry appears promising, driven by escalating domestic and international demand, fueled by a growing consciousness regarding dietary choices.

India possesses 148.8 million goats distributed throughout the country and has 39 registered breeds (NBAGR, 2024). The goat population is regularly increasing except 2012, when it declined by 3.82 percent in comparison to 2007, whereas 20th Livestock Census, 2019 revealed a 10.1% increase in goat population over the 19th census, 2012. The goat population has increased by 215% from 1951 to 2019 (Fig 1). Earlier, the goats were considered as an animal of the dry and arid region, but now the goats are omni-present irrespective of agro-climatic zones. It is expected that by 2030 and 2047, the goat population will be 176.6 and 237.9 million, respectively. Goat meat, chevon has huge demand in national and international market. India is producing 1.42 MT chevon which accounts for 14.5% of the total meat production of India. The high demand of chevon led to huge slaughter rate, 82.93% reported by DAHDF in 2023 (123.40 million) which was 8% higher than reported in 2019 (111.33 million; 74.84%). The high slaughter rate led to serious issue of slaughter of elite breeding animals.

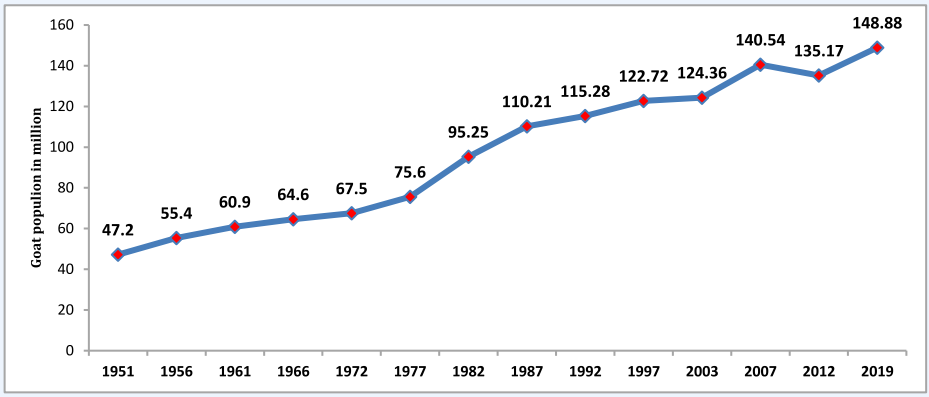


Fig 1. Dynamics of Goat Population in India

Goat milk is gaining popularity among consumers and is referred to as *"white gold"* because of its unique composition, components, and therapeutic potential. This has led to the regular increase in dairy goat population to 41.96 millions, accounts for 28.16% of the total goat population. As per the report of DAHDF, 2023; India is producing 7.59 MT of goat milk accounts for 3.3% of total milk production of India and 35.46 % of the world (21.4MT). The growth in dairy goat industry is estimated as 4%, by following same growth rate the estimated goat milk

output of India will be 24 MT by 2047. However, the major concern of Indian dairy goat is its productivity which is limited to average of 0.5 litre/animal/day and 181 litre/head (DAHDF, 2023). Indian goat sector annually contributes Rs. 1.31 lakh crores (on current prices) forming about 11.75% of the gross value products of animal husbandry (Table 1) (Chatli *et al.*, 2024). The goat population and its productivity can be further improved by breed improvement programme and use of research institutions (CIRG, SAU, etc.) developed technologies *viz.* standard goat health care practices, reproductive health and artificial insemination, balanced ration, adequate housing and strategic managemental practices.

Table 1. Estimated value of goat products of India in 2023 at current prices

Products	Production (MT)	Value (crores)
Milk	7.59	38,000
Meat	1.41	70,500
Skin/Hide	0.8 (111 million no.)	8,000
Byproducts (goat hair+SH offals)	1.8	6,481
Goat manure	45	4,500
Others	-	3,500
Total		**1,30,981**

Goat sector always remain low-profile due to more focus of all the policies on bovine production system. The majority of the government funds and efforts were directed towards cattle and buffalo production, whereas poultry has developed as industry with the contribution of private sector. However, the goat husbandry remains underdeveloped due to the low input by both government and private sector, moreover the majority of the associated farmers (95%) are marginal, landless and illiterate farmers, which were unable to adopt innovative technologies. In addition, there is low penetration of the extension activities of the animal husbandry, therefore, there is an urgent need to look into the factors for the synchronization of the productivity with the goat population for higher revenue generation and for the benefits of the

farmers. This is reflected by the facts that derived growth rate in goat sector is attributed to population increase then its productivity. A perusal of Fig 2 & 3 reveals that goat population increased by 215%, whereas milk productivity increased by 110% in the same period of 1951 to 2023. Similarly, the meat productivity increased by 44% from 2011 to 2023 whereas goat population increased by 69% in the same period.

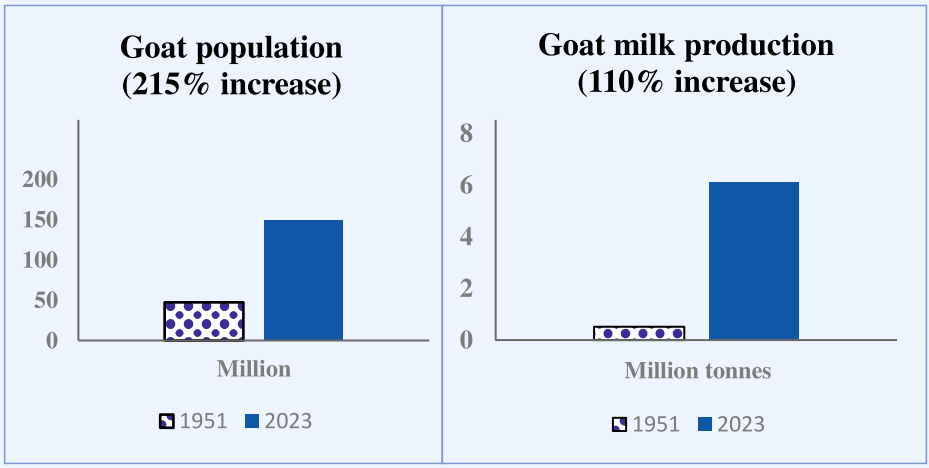


Fig 2. Comparative evaluation of goat population and goat milk from 1951 to 2023

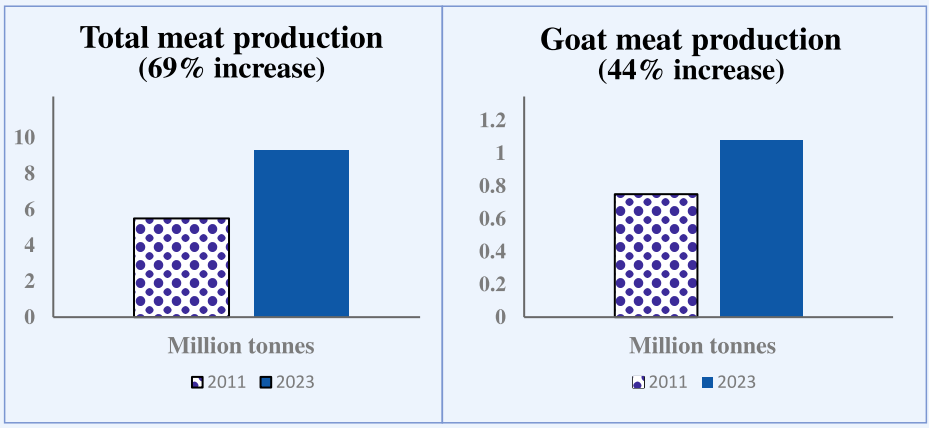


Fig 3. Comparative evaluation of goat population and goat meat from 2011 to 2023

Goat Production and Management System in India

In India, goat keepers predominantly belong to the landless or smallholder category, characterized by low levels of literacy and socio-economic backwardness. They typically engage in extensive management systems with minimal inputs for breeding, feeding, housing, and healthcare. However, the majority of goat flocks, exceeding 80%, are small to medium-sized, but their numbers are dwindling due to the gradual reduction of grazing land. Large goat herds are primarily concentrated in rain-fed areas such as Rajasthan, Gujarat, Andhra Pradesh, and the Trans-Himalayan region, where ample wasteland is available for grazing (Singh e*t al.,* 2008). Despite scientific advancements in husbandry practices, goat keepers from sedentary, nomadic, semi-nomadic, and economically disadvantaged backgrounds often lack the knowledge and resources to capitalize on these benefits. Management practices vary significantly between regions and even within households, complicating the development of effective breeding strategies. Unlike other livestock, the use of feedlots to fatten goats on high-energy concentrate diets prior to slaughter is uncommon, likely due to the absence of a commercial approach and the poor status of goat farmers. Although goat farmers may also raise other livestock species, poultry, and crops, integrated and diversified goat farm models tailored to different ecological regions remain lacking. Inadequate and improper housing conditions prevail, with over 90% of goats reared in substandard facilities. While traditional management practices are socially tolerant and sustainable, they often yield lower productivity and profitability. Moreover, the goat population is concentrated in rain-fed arid and semi-arid regions, where access to green fodder is restricted, seasonal, or severely limited. The significant decline in grazing resources and the subsequent increase in stocking rates have rendered extensive goat farming unsustainable and economically unviable.

Goat Genetic Resources of India

India is home to a diverse array of goat genetic resources, comprises 39 recognized breeds, alongside numerous lesser-known genetic resources. The leading states in goat population include Rajasthan, West Bengal, Uttar Pradesh, Bihar, Madhya Pradesh, and Maharashtra, collectively accounting for a significant portion of the nation's goat

population. These 39 goat breeds have evolved across diverse regions to meet the multifaceted needs of communities across the nation. Excelling within their respective habitats under optimal feeding conditions, these breeds demonstrate significant disease resistance and adaptability to climatic fluctuations. However, some breeds exhibit overlapping characteristics, potentially due to interbreeding in regions where multiple breeds coexist. Indigenous goat breeds, though less renowned for their productivity attributes, have historically been selected for adaptability to climatic stress and tropical diseases rather than genetic potentials for production traits (Singh e*t al.,* 2024). More than 60% of the goat population is predominately non-descript, with some populations holding potential for classification as new breeds.

The following section outlines goat breeds categorized by their broad agro-climatic regions and utility:

1. Northern Temperate Region:

- Changthangi, Chegu, Bhakarwali, and Gaddi are important breeds in this region.



Chanthangi buck



Chegu



Gaddi



Bhakarwali

- Chegu, Bhakarwali, and Changthangi are medium-sized and produce the finest quality undercoat hair called *'Cashmere'* or *'Pashmina'* in the northern upper Himalaya region (Laddakh and Kashmir) 3500 meters above mean sea level (MSL). The growth rate is moderate however, low in milk yield (20-30 litre/lactation) and in prolificacy (<10%).
- Pashmina yield in Chegu goats ranges from 60-80 g at one year of age to 125-200 g at 4 years, and Changthangi, increases from 70-150 g at one year to 200-400 g at 4 years.
- Gaddi, a medium breed, produces coarse fibre besides chevon and milk. Body weight at the age of one-year ranges from 18-25kg. Milk yield in a lactation range from 60 to 90 litres, and incidences of multiple births range from 15-25%.

2. North-Western Region:

- This region has 17 breeds, including Beetal, Jamunapari, Barbari, Rohilkhandi, Pantja, Sojat, Sirohi, Marwari, Gujari, Jakhrana, Karauli, Surti, Gohilwadi, Kutchi, Zalawadi, Kahmi, and Mehsana.



Barbari



Sirohi



Beetal



Jamunapari

- These goats range from medium to large in body size and are predominantly dual-purpose, with relatively higher milk yield ranging from 150 to 500 litres per lactation.
- Body weights at twelve months vary from 22 to 60 kg, and prolificacy ranges from moderate 25% to high 70%.
- Several breeds, including Beetal, Jamunapari, Sirohi, Sojat, Jakhrana, Surti and Barbari, are suitable candidates for improving non-descript goat breeds of arid and semi-arid regions in India.

3. Southern Region:

- In the Southern and Peninsular regions, breeds like Sangamneri, Osmanabadi, and Malabari are dual purpose breeds whereas, Konkan Kanyal, Berari, Nandi-durga, Bidari, Kannai-adu, Kodi-adu, Salem Black, and Black Attapady serve for meat purpose.
- These breeds demonstrate strong prolificacy, ranging from 40 to 70%.



Osmanabadi



Malabari



Salem Black



Kanni-Adu

- Medium-sized breeds reach a body weight of 18-26 kg at twelve months of age under semi-intensive management and 25-40 kg under intensive feeding regimes.

4. Eastern Region:

- Bengal or Black Bengal is the main breed in this region, distributed from eastern Uttar Pradesh, Bihar, Jharkhand, Bengal, Tripura, parts of Orissa, and Assam.
- It is a small-sized dwarf meat breed with great recognition for prolificacy, skin, and carcass qualities. Prolificacy ranges from 60-90%, however low in milk yield.
- Other important breeds in this region include Assam Hill, Sumi-Ne, Andmani, and Teressa, which are localized breeds known for their high prolificacy rates and quality skin production. Ganjam is another localized breed with huge recognition for adaptability for harsh climatic conditions however, have low prolificacy (<5%) and low milk yield (<40 litre/lactation).



Black Bengal



Andamani



Assam Hill



Ganjam

Growth Performance of Indian Goat Breeds

The average carcass weight of Indian goat breeds is approximately 10.4 kg, ranging from 4.5 to 25 kg, significantly lower than Asian and world averages. This diversity is primarily due to the predominance of prevalence of small-sized goat breeds, which constitute over 55% of the total goat population, suboptimal management (feeding) and sale at early ages (6-9 months). Carcass weight varies significantly based on breed, plane of nutrition, sex, type of birth, weaning and slaughter age. Dressing percentage among Indian goat breeds ranges from 38% to 56%, with smaller breeds generally exhibiting lower percentages compared to medium and large breeds. Contrary to expectation, age alone does not necessarily increase dressing percentage unless accompanied by a concurrent increase in body weight. Castrated males tend to gain more weight, resulting in higher carcass weight and dressing percentage. Studies on average daily weight gains (ADG) of kids across different growth intervals and breeds indicate maximum growth during the 0-3 month period, followed by 6-9 months. Reduced weight gains during 3-6 months are attributed to the waning influence of maternal care and dietary changes. Several factors contribute to variable ADG, including period, season, birth weight, and sex of the kid. Kids born during extreme climate (peak of summer, winter, and rainy season) tend to exhibit lower weight gains across all growth intervals, and also with higher incidences of morbidity and mortality. Numerous studies have identified sex, feeding system, and type of birth as primary sources of non-genetic variation. However, after 6 months of age, the effects of these factors become non-significant. Multiple births tend to result in higher average daily gains later in life compared to singles. Growth rate is further influenced by weaning age, weaning weight, and diet and/or its composition. Optimal weaning is typically observed at 8/9 weeks or 2.5 times the birth weight, with higher milk diets potentially inhibiting rumen development, emphasizing the importance of introducing solid feeds. Heritability estimates for growth traits such as body weights and ADG range from moderate to high (0.2-0.5), while estimates for feed efficiency are low to moderate (0.1-0.2). Indigenous breeds exhibit substantial genetic variability for growth and meat production traits, offering promising opportunities for exploitation through careful selection, balanced diets, and adequate healthcare. Heritability

estimates for growth traits range from moderate to high (0.2 to 0.5) across most breeds, indicating ample room for improvement. The genetic progress for growth traits through selective breeding in different breeds ranges from 0.2 to 0.5 kg/generation. (Annual Report, AICRP on Goat 2023; Bhat 1986, Singh and Singh2012, Singh e*t al.,* 2024).

Prospects of Dairy Goat Farming

Dairy goat farming in India holds great promise, driven by the nutritional superiority and unique qualities of goat milk. Compared to milk from other species, goat milk boasts higher levels of beneficial components like lactose-derived oligosaccharides and medium chain fatty acids. It also contains essential nutrients such as calcium, zinc, and vitamin A, while being easier to digest, non-allergenic, and naturally homogenized. These qualities not only make goat milk a healthier option but also enhance immunity against infections. The market for goat milk and its products, including flavoured milk, probiotic yoghurt, cheeses, ice cream, and bioactive peptides, is expanding globally. The season availability of the goat milk, pocketed production system, availability in small quantities act as road block for the development of market and processing of goat milk. Further, the demand for the goat milk increases mani-fold during summer season due to increased incidences of dengi virus etc. led to adulteration of the goat milk. Overall, the marketing structure for goat milk in India is underdeveloped, resulting in lower prices compared to other types of milk. This has discouraged farmers from rearing high-quality dairy goat breeds (Jamunapari, Jakhrana, Surti, Beetal, etc.), and investment in improvement (Singh *et al.,* 2023).

Factors Adversely Affecting Caprine Biodiversity and Sustainable Genetic Improvement

1. ***Lack of Adequate Breeding Policy for Different Regions:*** Indigenous goat breeds have evolved to thrive in diverse agro-climatic conditions across the country. However, past selection focused on adaptability rather than productivity enhancement, compounded by insufficient resources for feed, fodder, housing, and healthcare. Ineffectively implemented breeding policies have led to indiscriminate inter-breeding, diluting native breeds.

2. ***Poor Breed Base and Population Structure:*** India lacks comprehensive genetic repositories for its goat breeds, leading to unreliable population statistics. While overall livestock populations have increased, certain breeds like Jamunapari, Beetal, Sangamneri, Changthangi, and Surti have declined due to inadequate data management and ineffective breeding policies and non-adoption of participatory structural breeding program.

3. ***Non-Judicious Crossbreeding with Exotic Breeds*:** Crossbreeding aimed to enhance local goat genetics often lacked proper planning and implementation, resulting in limited improvements in productivity and high mortality rates among crossbred populations. Exotic germplasm has been indiscriminately used without clear breeding programmes in some regions like Maharashtra, Kerala and in other southern states.

4. ***Habitat Loss:*** Rapid urbanization and land degradation have led to the loss of grazing lands and natural habitats for indigenous goat breeds. Diminished habitat availability has forced goats into new areas, leading to unintended crossbreeding and genetic dilution.

5. ***Non-judicious Conservation Policy:*** Inadequate conservation efforts have led to the decline of important breeds like Jamunapari, Sangamneri, Surti and Barbari. Policy decisions such as bans on breed sales outside home tract in certain states have adversely affected breed remuneration, prompting farmers to shift to other breeds.

6. ***Indiscriminate Sale/Slaughter of Elite Animals:*** Poor goat keepers often sell elite male kids prematurely, leading to negative selection and a decline in genetic potential. This practice undermines breed improvement efforts and profitability.

7. ***Marginalization of Goats:*** Goats have received less attention and investment compared to other livestock species at both the national and household levels. This has hindered goat improvement programmes and led to neglect even in rural households.

8. ***Lack of Breed Improvement Programmes:*** Limited awareness and motivation among goat keepers have resulted in

indiscriminate breeding practices. Neglect of breed-specific management and selective breeding has led to the decline of highly remunerative breeds like Jamunapari and Jakhrana.

9. ***Climatic Stress and Natural Calamities:*** Despite their adaptability, indigenous goat breeds suffer during natural disasters such as avalanches, tsunamis, floods, and droughts.

10. ***Human Population Explosion and Illiteracy:*** Human population growth and illiteracy contribute to habitat encroachment and environmental degradation, further endangering indigenous goat breeds and biodiversity. Literacy and awareness are crucial for sustainable conservation efforts.



Challenges in Goat Production

Goat production encounters numerous constraints that impede its productivity and profitability, encompassing various aspects of the production system as follows (Chatli *et al.,* 2024):

- The prevalence of non-descript (>60%) or poorly bred animals contributes to low productivity. Lack of organized breeding programmes leading to lesser productivity. In general, grazing systems is unorganized where females of different breed or non-descript graze together with male of different breeds leading to breed dilution issues.
- Data recording in field flocks is difficult, time taking, costly and process is tedious. Nearly 85% farmers kept small flock moreover, as flocks go out for grazing, so farmer and their animals are available at home only in odd hours, therefore recording data by the data enumerators is also difficult.
- The shortage of quality breeding bucks due to indiscriminate castration and sale, and lack of awareness results in indiscriminate breeding, breed dilution, and limited genetic improvement.
- Inadequate availability of feed and fodder affects goat productivity and immunity, making them susceptible to diseases.
- Goats often suffer from inadequate space and improper housing conditions, further impacting their well-being and productivity.
- Maintaining the genetic diversity of indigenous goat breeds amidst increasing crossbreeding with exotic breeds as well as within indigenous breed's poses a significant challenge.
- Insufficient allocation of resources towards research and development poses a momentous obstacle to the identification of desirable traits and the formulation of effective breeding strategies. Identification of genetic markers for the early selection of elite doe and bucks is still a challenge for all the breeds.
- The absence of modern infrastructure, such as semen banks, nucleus breeding farms, and research facilities, poses challenges to the adoption of advanced breeding techniques.

- Climate variability affects goat productivity, health, and breeding practices, necessitating adaptive strategies to mitigate its impacts.
- Controlling infectious diseases such as *Peste des Petits* Ruminants (PPR), Foot and Mouth Disease (FMD), and gastrointestinal parasites is very important for sustaining goat populations.
- Farmers often face challenges in accessing high-quality breeding stock due to geographical constraints, lack of transportation facilities, and limited availability.
- Inadequate market linkages and price fluctuations discourage farmers from investing in improved breeding practices, affecting the overall profitability of goat farming.
- Insufficient awareness regarding modern breeding techniques and limited access to training opportunities for farmers act as obstacles to the widespread adoption of scientific goat breeding practices. There is a significant knowledge gaps regarding improved management practices and technologies in goat farming.
- Lack of coordination among government agencies, research institutions, and private stakeholders leads to a fragmented approach to goat breeding and conservation efforts.
- Women, who often play a significant role in goat rearing, face gender disparities in accessing training, resources, and decision-making power in breeding-related matters.
- The scarcity of veterinary services results in high mortality rates due to inadequate prophylactic measures.
- The lack of organized marketing channels and infrastructure for value addition further hampers the profitability of goat farming.
- To counter the trend of today's youth favouring professions outside agriculture, there is a need to motivate them towards livestock enterprises by showing the regular returns and business opportunities available in this sector.

Past Genetic Improvement Programmes and Strategies

Goat Improvement Programmes in India

During the pre-independence period, various missionaries, voluntary organizations, and non-governmental organizations initiated sporadic developmental work in certain regions of India, introducing breeds such as Swiss-Alpine, Israel-Saanen, and Boer goats, particularly in Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Himachal Pradesh, and Jammu & Kashmir. In 1939, a goat improvement programme was launched at the government livestock farm in Hisar, aiming to enhance milk production through the selection of Beetal goats. However, the results of this programme were not satisfactory due to high levels of inbreeding resulting from small flock sizes. Post-independence, some work on goat development was conducted at RBS College in Bichpuri, Agra, focusing on Beetal, Jamunapari, Black Bengal, and Sirohi breeds. Subsequently, a few missionary, voluntary, and non-governmental organizations also initiated goat development efforts by crossbreeding local goats with Saanen, Alpine, Anglo-Nubian, Toggenburg, and Boer breeds.

Indo-Swiss Goat Development and Fodder Production Project (ISGP)

The Indo-Swiss Goat Development and Fodder Production Project (ISGP) was initiated in 1981 in Rajasthan with the aim of enhancing goat production through genetic improvement, fostering fodder production, and establishing marketing infrastructure. Implemented by the State Animal Husbandry Department of Rajasthan with technical support from Inter cooperation, Switzerland, the project primarily targeted improving the income and nutrition levels of rural families, especially those from marginalized communities, by developing effective goat production models in the semi-arid farming systems of Rajasthan. Exotic breeds such as Alpine and Toggenburg were used as breeding bucks to improve milk yield. The crossbred goats showed a slight increase (23%) in milk yield compared to Sirohi goats, but with lower kidding rates (69%) in crossbred goats. Lactation milk yields at 60 and 180 days were

recorded as 90±29.7 kg and 245.3±74.2 kg, respectively. These findings underscored the significance and potential of Sirohi goats for their adaptability, performance, and contribution to the livelihood security of impoverished communities. Sirohi goats gained recognition as an improver breed suitable for harsh climatic conditions, particularly in semi-arid regions. In 1989, a 'milk recording and buck rearing scheme' was introduced, wherein potential breeding bucks were identified at 2-3 months of age from does with lactation yields exceeding 300 kg at 180 days. These bucks were purchased by ISGP at one year of age. Operating in 146 villages with 677 goat keepers and 564 'poorest of the poor' goat keepers owning around 18,000 breedable does, the project concluded in 1992, leaving behind improved genetic models and extension programmes (ISGP 1992; Rai e*t al.,* 2005).

All India Coordinated Research Project on Goat (AICRP)

During the Vth Five Year Plan in 1971, the Indian Council of Agricultural Research (ICAR) initiated the All India Coordinated Research Project on Goat (AICRP) to enhance the genetic potential of indigenous goat breeds for improved milk, meat, and mohair yield. This involved cross-breeding indigenous breeds with high-yielding exotic breeds and other superior indigenous breeds. The project was headquartered at NDRI, Karnal from 1970 to 1974, CSWRI, Avikanagar from 1974 to 1976, and CIRG Makhdoom thereafter. Exotic dairy breeds such as Alpine, Saanen, Anglo-Nubian, and Toggenburg were identified, while Beetal and Malabari goats were selected as indigenous breeds to enhance milk potential through crossbreeding. Gaddi and Sangamneri were chosen as native breeds, and Russian Angora as the exotic breed for mohair production. Additionally, the AICRP aimed at increasing the quality and quantity of pashmina in Changthangi goats through selective breeding. In the VIth plan, three units were added to improve meat potential through crossbreeding with indigenous improver breeds and selective breeding. The AICRP on Goats in the VIth plan encompassed two units for milk, two for pashmina, and one for mohair. The primary objective of crossbreeding Indian goats with exotic breeds was to develop new breeds suitable for local agro-climatic conditions, capable of yielding at least 300 kg of milk in a lactation period of 150 days. The first unit of the AICRP on Goats for milk was established at NDRI, Karnal in 1971,

utilizing Beetal goats and Alpine and Saanen as improver exotic breeds. Similarly, another unit was established at KAU, Thrissur in 1972 to develop a new milch goat breed capable of yielding 200 kg of milk in a lactation period of 200 days, using Malabari goats as dams and Alpine and Saanen as improver exotic breeds.

The AICRP on goats for mohair production commenced in 1972 at Mahatma Phule Krishi Vidyapeeth in Rahuri, Maharashtra, with the aim of developing a mohair breed of goat capable of reaching an average body weight of 30 kg at 3 years of age and producing 2 kg of mohair per year. The desired fibre characteristics included an average diameter of 30 microns and a staple length of 10 cm, tailored to suit local agro-climatic conditions. Gaddi and Sangamneri were utilized as native breeds for crossing, while Russian Angora served as the exotic breed. Initially, the 7/8 Angora exhibited superior mohair yield and quality compared to other genotypes, despite its poor reproductive efficiency. Consequently, reciprocal cross-breeding between 3/4 Angora and 7/8 Angora was conducted to address this issue. However, the commercialization of mohair production among farmers remained low due to the limited quantity of mohair yield. While the quality and yield of 7/8 Angora were commendable, attempts to cross Angora with Gaddi and Sangamneri did not yield favourable results until the Angora bloodline reached 87%. Moreover, higher grades of Angora exhibited poor feed conversion efficiency and lower reproductive traits. Ultimately, the project was terminated during the VIIth plan (1992-97) due to high mortality rates and a lack of market value for mohair.

The outcomes of crossbreeding experiments, particularly involving exotic strains, did not yield highly promising results in terms of meat and milk production. Consequently, there was a realization that enhancing indigenous breeds, which are well-suited to local conditions, should be prioritized through selective breeding within the breed. Under the AICRP on goats, three farms were established: Black Bengal in 1976 at BAU, Ranchi; Assam local goat in 1977 at AAU, Bernihat; and Shingari in 1983 at Jorethang, Sikkim. The aim was to develop meat goat breeds adapted to local agro-climatic conditions, capable of reaching a body weight of 15 kg at 6 months under intensive feeding. Through diallel crossing of Jamunapari, Beetal, Barbari, and Black Bengal, it was

revealed that Jamunapari was superior in milk yield, while Beetal excelled in carcass and reproductive traits. Beetal emerged as a better improver goat over Jamunapari due to its adaptability and reproductive performance, except in Sikkim, where crosses of Jamunapari and Shingari performed better. Crossbreeding led to improved performance of Shingari goats, with Beetal and Jamunapari single born male kids weighing 13.30 and 15.66 kg, respectively, at 6 months. Experiments involving Black Bengal and Jamunapari crosses indicated that selective breeding within Black Bengal was more suitable for live weight gain and carcass value improvement. Although crossbreds exhibited superiority in body weight at early ages, kidding efficiency, multiple births (%), feed efficiency, and dressing percentage, they also faced higher age at first kidding and mortality rates. Consequently, the project was closed during the IXth plan, as improvement was not sustainable over the generations however Beetal was observed as a better improver breed in the Chhotanagpur plateau region.

The AICRP on goats at Central Sheep and Wool Research Institute (CSWRI) Avikanagar, Rajasthan commenced in 1976 to assess the purebred performance of significant indigenous breeds such as Sirohi, Marwari, and Kutchi under semi-intensive and intensive feeding systems. The six-month body weight of Sirohi, Marwari, and Kutchi male kids was 26.4, 24.7, and 25.4 kg, respectively, under intensive feeding. Sirohi exhibited the highest feed conversion ratio, followed by Kutchi and Marwari, showcasing good performance under the semi-arid agro-climatic conditions of Rajasthan. Initiated in 1987 under the VIIth five-year plan, the AICRP on Goats for milk at R.A.U., Bikaner aimed at enhancing milk production in Jakhrana goats through selection. However, the focus later shifted to Marwari for both meat and milk production to drive improvement in the farmer's flock.

The All India Coordinated Research Project on Goat underwent a strategic shift in the VIIth five-year plan (1992–97), transitioning from crossbreeding to selective breeding to enhance meat and milk production in indigenous breeds in their habitat. The project was succeeded by the "Network Project on Goat Improvement," launched on April 1, 1990, with a focus on defining, characterizing, and enhancing the productivity of indigenous breeds through selective breeding in their

natural habitats. Three indigenous breeds; Marwari, Sirohi, and Malabari were identified for improvement in their respective breeding tracts at Bikaner, Avikanagar, and Trissur, respectively. During the VIIIth year plan, the project emphasized involving institutional farms as nucleus herds and maintaining village flocks by farmers. Institutional flocks at CIRG, Makhdoom, and CSWRI, Avikanagar, were established for Jamunapari, Barbari, and Sirohi breeds, respectively, with each unit maintaining a minimum of 300 does and 10 bucks. The selection of male kids was based on an index combining dam's milk yield and the kid's body weight at 6/9 months of age. However, limited genetic progress was observed in the VIIth plan due to low selection intensity and imprecise estimates of genetic parameters, attributed to moderate to high mortality in farm units from 1993 to 2000.

The institute-based farms are showed a good rate of genetic progress for economic traits with low mortality rates (<5%) and precise genetic parameters. These farms are also involved in *in-situ* and *ex-situ* conservation, development, refinement, and transfer of production technologies for commercial goat farming and livelihood models for poor households. Since 2006, superior animals of Barbari, Jamunapari, and Sirohi breeds have been supplied to fields every year to improve farmers' flocks. Field units for Jamunapari and Marwari breeds were part of the VIIIth plan, focusing on their improvement with special attention on Jamunapari breed and productivity enhancement of Marwari goats in farmers' flocks. However, the Jamunapari field unit was closed in the Xth plan. During the IXth plan, six new field units were added for breeds like Black Bengal, Ganjam, Sangamneri, Surti, Malabari, and Sirohi to improve productivity, conserve breeds in-situ, and produce superior bucks. The Xth plan saw the addition of three more breeds and four new centers, further widening the technical programme to include region-specific technologies and the validation of these technologies under farmers' flocks. Results have shown significant improvement in production performance across different goat breeds in farmers' flocks and institute flocks, although progress has shown fluctuating performance trends based mainly on phenotypic values of economic traits. The project has also focused on developing region-specific management practices, goat breed societies, cooperatives, marketing infrastructure, and capacity building for goat keepers. Under the present

XII plan, there is a greater emphasis on building multiplier flocks at farmers' flocks to widen genetic variability and fulfill the requirement of superior germplasm for a large number of farmers. Krishi Vigyan Kendras located in the home tracts of concerned breeds and state animal husbandry department are also involved in disseminating improved management practices, including breeding bucks. The project focuses on intensifying community breed improvement, dissemination of improved management practices and technologies, increase in the number of adopted villages/registered goat keepers and focus on proper identification, precise and uniform data collection patterns, and follow-up to evaluate the impact of germplasm distribution for genetic improvement and income generation (Mishra, 1985; Singh and Sengar, 1990; Singh *et al.,* 2014; PC Report 2023).



Goat Disease Prevalence and Economic Impact

Effective veterinary services, including vaccination, disease diagnosis, and control programmes, are critical for improving goat health, enhancing productivity, and mitigating significant economic losses in goat farming (Clemmons e*t al.,* 2021). This section of the document critically examines the prevalence, economic losses, and impact of major goat diseases in India, such as Peste des Petits Ruminants (PPR), Goat Pox, Foot and Mouth Disease (FMD), Brucellosis, and Contagious Caprine Pleuropneumonia (CCPP).

Peste des Petits Ruminants (PPR) exhibits significant seroprevalence variations across India, resulting in annual economic losses of Rs. 11,074.6 million. Mortality and morbidity losses account for Rs. 8,110.4 million and Rs. 2,964.2 million, respectively (Balamurugan *et al.,* 2021). At a 10% incidence rate, the total economic loss is estimated at Rs. 16,110 million. A nationwide serosurvey conducted in 2017–2018 using PPR competitive ELISA indicated a 10% incidence level in goats, leading to weight loss, increased inter-kidding periods, abortions, milk loss (Rs. 65.9 million), higher feeding and rearing costs, and other miscellaneous losses (Govindaraj *et al.,* 2016).

Goat Pox presents a significant threat, characterized by pyrexia, generalized pock lesions, and lymphadenopathy, with mortality rates ranging from 50% to 100% and morbidity rates up to 100% (Babiuk *et al.,* 2008). The seroprevalence of Goat Pox is 21% (Suresh *et al.,* 2022), causing annual losses of US$27.47 million (Rs. 1,250 million). The economic benefits from control programmes if effectively implemented could significantly outweigh the costs, with a benefit-cost ratio (BCR) of 19:1, primarily due to an 8.01% reduction in the cost per tonne of goat meat production owing to decreased incidence and mortality (Bardhan e*t al.,* 2020).

FMD in goats, though less severe than in other livestock, results in substantial annual economic losses totaling Rs. 52.52 lakh. Morbidity-related issues, such as reduced growth and reproductive failures, account for 0.96% of the total economic losses from FMD across all livestock. Growth and milk production losses alone represent more than

40% of the total losses in goats due to FMD (Singh *et al.,* 2013a). The relatively low vaccination coverage among goats against FMD exacerbates these losses, highlighting the need for improved vaccination strategies.

Brucellosis, despite a low prevalence of 4.09%, causes significant economic losses amounting to Rs. 506.19 crore A critical analysis reveals that about 40 per cent of the losses incurred are due to reproductive losses mainly due to abortions, infertility, increased inter-kidding period etc. (Bardhan *et al.,* 2020). While another report projected the annual median losses to Rs. 5,942.8 crore with loss per goat calculated to Rs. 41.5. These losses are driven by reproductive inefficiencies and production losses, challenging the economic stability of goat production in India.

Contagious Caprine Pleuropneumonia (CCPP) is causes severe respiratory distress in goats, characterized by fever, coughing, and difficulty breathing. The disease is highly contagious, resulting in high morbidity and significant mortality rates, severely impacting goat populations and causing substantial economic losses globally. Based on recent studies, CCPP has a pooled prevalence of 24.91% (95% CI: 20.99–28.84%), varying by region from 3.70% to 51.65% depending on the country. Notably, in subgroup analyses, the prevalence is 26.58% in adult goats and 21.47% in young goats. The disease exhibits a high morbidity rate of 100% and a mortality rate of 80%, emphasizing its severity. Economically, CCPP imposes a significant burden, with the global cost estimated at US$ 507 million per annum (Ahaduzzaman, 2021).

Though comprehensive data from cited studies highlights the prevalence and economic impact of diseases in goats, there are notable gaps. These studies are based on regional outbreak studies and the data is extrapolated using various mathematical models. Therefore, it varies with different agro-climatic zones, innate breed resistance to specific diseases and prevalent health, nutrition and managemental practices. Economic analyses often overlook indirect costs like impacts on household income and food security. Furthermore, detailed studies on the long-term economic benefits of vaccination and control programmes are lacking, which could offer insights into their cost-

effectiveness. Additionally, regional disparities in disease prevalence and economic impact are not thoroughly explored, which could inform more targeted intervention strategies.

Improved diagnostic methods, robust vaccination programmes, and better management practices are essential for addressing health losses in goats. Implementing effective veterinary services is crucial for mitigating the financial impact of these diseases and enhancing the sustainability of goat farming in India. Policymakers must prioritize these interventions to ensure the health and productivity of the goat population, ultimately contributing to the economic stability of the agricultural sector.

Parasitic diseases in goats significantly hinder optimal productivity. The diverse ecological zones and varied rearing systems influence the incidence of various parasitic agents, including Gastrointestinal (GI) nematodiasis (due to *Haemonchus contortus*, *Oesophagostomum* sp., *Trichostongylus* sp., and *Bunostomum* sp.), Monieziasis, Coenurosis, Hydatidosis, Amphistomiasis, Fascioliasis, coccidiosis, and ectoparasitic infestations. The economic losses are attributed to morbidity, mortality, and control expenditures, alongside reduced production of meat, milk, and fibres. Despite the serious economic implications, comprehensive efforts to quantify these losses are lacking. However, a study conducted in Tamil Nadu (Ilangopathy *et al.,* 2019) estimated the total economic loss due to GI nematodes from Rs. 1194 to Rs. 1674 /animal. Essential measures include pre- and post-monsoon deworming, appropriate pre-season dipping, and annual rotation of anthelmintic classes to mitigate drug resistance. Targeted Selective Therapy (TST) using eye-mucosa-based colour charts (FAMACHA/PARACHEK Card) and protein supplementation during rainy season is recommended.

Hence, there is a pressing need to intensify production systems, improving management practices, accurate reporting of economic loss due to parasitism are crucial for improving goat farming productivity and sustainability in India. In addition, the stress should be given for the vigilant monitoring of drug resistance issues.

Reproductive Health and AI Technologies

Effective reproduction is paramount for sustaining and expanding herd size, directly influencing the profitability of goat farming. Any disruption in normal reproductive processes can lead to substantial economic losses due to decreased fertility and reproductive failures. Key reproductive challenges in goats include abortions, prolonged kidding intervals, high mortality rates, and conditions like metritis leading to incidences of low conception rates.

To mitigate these losses, goat farmers adopt strategic measures such as investing in high-quality breeding stock, conducting thorough breeding soundness evaluations, and ensuring optimal herd health. These proactive steps not only safeguard against reproductive issues but also bolster the overall productivity and profitability of goat farming operations. By prioritizing reproductive health, farmers can maintain robust herd dynamics and secure long-term economic success in the industry.

The artificial insemination (AI) in goats holds significant importance in the establishment of quality breeding stock besides improving breeding efficiency, genetic progress, and overall productivity of the herd. In India, the major portion of goat farming is extensive and the breeding system follows uncontrolled natural mating. Moreover, the gradual disappearance of the pure germplasm line, the decline of the pure breed from their native place is now becoming an issue worldwide. The low male to female ratio in the goat population has also become the biggest problem due to indiscriminate slaughter of the fast-growing male goat and early castration of the male kids. For this reason, more than 30% of oestrus does remain without service due to the unavailability of suitable breeding bucks (Karim *et al.,* 2019).

According to the 20th livestock census of India, there is a notable decrease of 14.65% in the male goat population, which now stands at 32.10 million compared to 37.62 million in 2012. Conversely, the female goat population has increased by 19.71%, reaching 116.78 million from 97.56 million in the previous census. These figures underscore the importance of effective breeding strategies. To meet the needs of

approximately 71 million breedable does in India, almost 1.5 to 2.0 million elite bucks are required. In contrast, the use of Frozen Semen AI Technology necessitates only about 50,000 elite bucks. This highlights the potential of AI technology to significantly contribute to the conservation efforts of threatened goat breeds such as Jamunapari, Jakhrana, Surti, Beetal, and Sangamneri.

Moreover, AI technology can enhance the productivity and performance of over 100 million non-descript and low-productive goats across the country. By leveraging AI, farmers can improve breeding outcomes, genetic diversity, and overall herd health, thereby ensuring sustainable growth and profitability in the goat farming sector. This approach not only addresses current challenges but also paves the way for long-term conservation and advancement within the industry. CIRG has standardized the technologies for cryopreservation of semen and standard operating procedures for AI of goats. CIRG regularly supplies semen straws of pedigreed animals and conducts training programmes for different stakeholders.



Feed and Fodder Requirements

In India, grazing-based livestock husbandry plays an important role in the rural economy as around 50% of animals depend on grazing. Out of total livestock, buffaloes and crossbred cows, owned mainly by people with arable land and resources to grow or procure green fodder; however small ruminants like goats and sheep, survive mainly by free grazing on the available pasture lands and tree foliage (Anon, 2011). Goat farming in India and other tropical regions has been pasture based since ages, but in the recent years grazing resources are diminishing due to land reclamation for conventional crop production or non-agricultural uses. Feeding systems for goat have been developed on the basis of climatic conditions, agriculture patterns, region, utility and economic conditions of the farmer. More than 80% of goats meet their nutrient requirement from the grazing alone on common property resources. The area covered by permanent pastures and other grazing land is 10.34 M ha and total CPR other than forest are 54 Mha whereas area for fodder cultivation is 9.13Mha (Directorate of Economics & Statistics, DAC&FW, 2020). All these figures are dynamic and declining with time. Crop residues are expected to provide 54% of total fodder, while rangelands provide 18% whereas only 28% is met from cultivated fodder crops (Hegde, 2006). There is currently a net deficiency of 35.6% green fodder, 10.95% dry fodder and 44% concentrate feed materials in the country with respect to total livestock population (IGFRI Vision, 2050). In the year 2050, with the current rate of expansion in forage supplies, there will be an 18.4% deficit in green fodder and a 13.2% shortfall in dry fodder. Small ruminant like sheep and goat are mainly reared by the resource poor people so the dependency on common grazing land and pasture land is more as compared to farmers of large ruminants. Keeping a carry capacity of 2 cow units per hectare of land in permanent pastures and other grazing land it can accommodate 20.68 million cow units. Approximation of four goats for 1 cow unit present population of goats is equivalent to 37.22 million cow unit. With these estimates, it can be predicted that there is around 40-50% of short fall of pasture for the entire goat population of the country. This pasture land is also used by other livestock to meet their nutrient requirement.

Therefore at least 60-70% of the requirement of the goat should be met through cultivated fodder crops, crop residue and concentrate and 15-20% from fodder trees for the proper productivity of the goats. The deficiency will further rise by 2050 with an expected population of 237.9 million. It will be very difficult to raise the goats on pasture-based grazing system. In addition, it is pertinent to mention that this pasture land is also under continuous degradation and productivity of pastures is also falling due to overgrazing. There is a lot of difference in the extent of grazing lands in various states. In some states *viz.* Himachal Pradesh, Jammu and Kashmir, Meghalaya, Nagaland and Arunachal Pradesh the grazing land availability is as high as 70%. The northern region has pasturelands in Jammu and Kashmir, Himachal Pradesh and Uttaranchal. This region has a potential resource in the form of green meadows and pasture, which at some places are mixed with the forests. The alpine meadow has an important economic value, providing pasture for the sheep and goats. The western India includes the pasturelands of Rajasthan and Gujarat. The land under permanent pasture is about 5.4% in Rajasthan and 3.5% in Gujarat, providing good quality fodder for livestock. Observance of goat dominated states revealed that total pasture and green fodder availability was deficient in Rajasthan (-32.70%), West Bengal (-38.20%), Uttar Pradesh (-23.60%) and Bihar (-28.40%). Situation is better in Madhya Pradesh and Maharashtra where surplus green fodder is available in the tune of 47.50% and 20.20% for feeding of livestock (Roy et al., 2019). In view of the above discussion, there is urgent need to emphasize the maintenance and productivity of pasture land. Feeding of goats in intensive system is need of hour for the future goat farming. The commercial goat farmers should also be encouraged for feeding of goats on stall system with total mixed ration, complete pellet feed or straw/ concentrate/ green fodder. A number of complete pellet goat feed having different feed resources has also been formulated and evaluated under different agro-climatic and environmental condition at ICAR-Central Institute for Research on Goats, Makhdoom, Farah. This complete feed technology will be the backbone for future goat feeding. The goat feed resource base needs to be widened through conversion of fallow and under-utilized land resources into multi-tier pasture and utilizing the produce in an effective manner.

Commercial Goat Farming and Marketing Strategies

Commercial goat farming as an entrepreneurial endeavor is flourishing due to its low initial investment, higher rate of returns (65-70%) and minimal risks. In response to market signals, India's goat production is shifting from extensive to semi-intensive/intensive management systems, boosting commercial prospects significantly.

The major challenges before commercial goat farmers include lack of access to resources, increasing feed ingredients prices, limited knowledge on good practices, poor access and supply of good quality germplasm, timely veterinary services, unorganized markets, climate and environmental factors, poor access to financial institutions and appropriate sector policy.

For the successful goat enterprise, the productivity and profitability can be improved by scientifically validated technological interventions developed by various research institutions on breeding, health, nutrition and marketing. Impact assessment of CIRG health and breeding calendars, area specific mineral mixtures and feed formulations was exhibited through improved prolificacy, lowering of morbidity and mortality (<5%) increment in body weight and milk yield. Marketing intervention was assessed in terms of better price realizations with the sale of animals at commercial age. Disaggregated analysis of net gain by individual interventions in the form of gross gain to cost ratio indicated that the health intervention generates more net gain with highest gross gain to cost ratio (3.56) followed by breeding (2.38), marketing (1.87) and nutrition (1.57) (Dixit *et al.*, 2015).

Goat markets in India are mostly unorganized and carried through traders/contractors or in *bakra mandis/haats* which lacks even basic facility of weighing of animals. These markets do not maintain any record of traceability of the animals. In general, the average flock size with the farmers is 3-7 goats and rearing is carried out on zero input system. In these cases, the market transactions involve middlemen like itinerant traders and local aggregators. These intermediaries purchase goats from farmers many of the times at very low price attributed to

forced sale due to immediate requirement of cash by them. These goat farmers have limited access to direct markets due to geographical remoteness, lack of transport and restrictive regulations. Moreover, price fluctuation is common phenomena ascribed by festive season demand, seasonal fluctuations, and consumer preferences. However, in commercial goat farming, the challenge shifts to securing optimal prices through direct sales efforts including digital marketing channels.

Therefore, the promotion of goat-based farmers producer organizations (FPOs), cooperatives and self-help groups (SHGs) to support small-scale goat farmers for collective marketing. Government agencies and extension services can help to provide timely market information, pricing trends, demand forecasts to assists them in making decision. Furthermore, the implementing of clear regulations and standards for the sale of goats and their products may improve buyers' confidence and marketability.



Policy Recommendations

Sustainable management of goat diversity in India is of paramount importance, considering their contribution to livelihoods, agro-climatic adaptability, and the progressive market demand for goat products. A holistic breeding strategy needs to be developed to ensure long-term conservation and productivity enhancement of the native goat breeds encompassing diverse aspects of genetic improvement, sustainable practices, and market-oriented goals. The recommendations are placed for the all-inclusive development of Indian goat sector including the factors related with nutrition, health, slaughter policy, marketing and capacity building programmes.

1. ***Tailored Breeding Strategies*:** Breeding strategies for goats should be customized for each breed, taking into account their adaptability to specific agro-climatic regions, body size, and marketable utility. This approach ensures that breeding programmes are effective in improving desired traits without compromising the breed's ability to thrive in its natural environment. Additionally, region-specific packages of practices on nutrition, healthcare, management, housing, and skill development should be developed and implemented to support the overall improvement of each breed.

2. ***Market-oriented Breeding Goals*:** Breeding goals for goats should be aligned with market demands for milk and meat, while also preserving the breed's inherent characteristics such as adaptability, climatic resilience, and morphometric attributes. This ensures that breeding programmes not only improve productivity but also maintain the unique qualities that make each breed valuable.

3. ***Establishment of Buck Mother Farms/Nucleus Flocks*:** To support a breed improvement programme, it is essential to establish buck mother farms or nucleus flocks for potential breeds such as Gaddi, Barbari, Sirohi, Sojat, Beetal, Osmanabadi, Black Bengal, Surti, and Malabari. These farms should be equipped with a semen lab and operated in a *'Public-Private-Partnership'* mode to

ensure a consistent supply of quality animals and semen to farmers. The flock strength of these farms should be between 500-1000, with 300 to 500 breeding females to ensure adequate genetic variability and sustainable genetic progress. Real-time data recording systems should be implemented to monitor genetic evaluation of bucks and their utilization. Additionally, the nucleus flocks should remain open for gene in-flow from the field area of operation to maintain genetic diversity.

4. ***Evaluation of Milk and Meat Quality*:** It is imperative to conduct comprehensive evaluations of the milk and meat quality of different goat breeds under various nutritional regimes. This exploration will provide valuable insights into the health attributes of milk and meat produced by Indian goat breeds. By assessing factors such as protein content, fat composition, flavour profiles, and nutritional value, we can better understand the overall quality and suitability of goat products for consumer preferences and dietary requirements. Such evaluations can inform breeding programmes and management practices aimed at enhancing the quality and marketability of goat-derived products.

5. ***Community-based Goat Breed Improvement Programmes*:** Developing community-based goat breed improvement programmes is essential for enhancing overall productivity and profitability at the village level. These programmes should involve active participation from local communities, breeders, and relevant stakeholders to ensure their effectiveness. Standardized breeding practices, integrated with other management techniques, can mitigate the adverse effects of climate change and promote sustainable goat farming practices. By empowering communities to actively engage in breed improvement initiatives, we can foster resilience and adaptability within local goat populations, thereby enhancing their long-term viability and economic value.

6. ***Development of Model Management Practices*:** A model package of management practices tailored to the specific needs of potential goat breeds in different agro-climatic regions is crucial for optimizing productivity and minimizing critical gaps in husbandry

practices. These practices should encompass breeding, nutrition, healthcare, housing, and other essential aspects of goat farming. By developing, validating, and implementing such model practices, we can ensure the seamless transition of breeds from extensive to semi-intensive or intensive production systems, as well as stall feeding. Additionally, specific packages of practices should be devised for migratory flocks managed by pastoralists, with necessary technical and input support provided by relevant state departments. This approach will promote sustainable livestock management practices while enhancing the livelihoods of pastoral communities. Robust database on production and productivity aspects of migratory flocks along with their migration track records and resource mapping to support pastoralists are essential for conserving specific breed characteristics. Some goat breeds are reared by particular communities with large flocks and they are residing in disadvantageous regions. Such flock owners may be prioritized and supported for selective breeding and required input support.

7. ***Development of Cloud-based Data Management System***: Collaboration with institutions like ICAR-IASRI can facilitate the development of a robust cloud-based data management system for goat breeding and farming. This system would serve as a centralized platform for collecting, storing, and analyzing data related to various aspects of goat husbandry, genetics, and performance. By leveraging cloud technology, stakeholders can access real-time information from anywhere, enabling informed decision-making and efficient resource allocation. The system can include features such as pedigree tracking, health records, production metrics, genetic evaluations, and market trends. Additionally, advanced analytics tools can provide valuable insights to support breed improvement programmes, research initiatives, and policy formulation in the goat farming sector.

8. ***Conducting Crossbreeding Experiments***: Crossbreeding experiments with exotic breeds should be conducted exclusively for research purposes to evaluate their potential impact on production, climate and disease resistance, adaptability,

management practices, and market resilience. These experiments should be conducted with careful consideration of the relative advantages of exotic breeds compared to indigenous ones, assessing factors such as productivity, adaptability, and profitability over the long term. Comprehensive studies should be undertaken to quantify the benefits and drawbacks of crossbreeding in terms of enhancing goat performance, addressing climate challenges, and meeting market demands. Findings from such experiments can inform breed improvement strategies, breeding policies, and conservation efforts aimed at preserving indigenous genetic diversity while exploring avenues for genetic enhancement through controlled crossbreeding.

9. ***Incorporation of Modern Tools for Genetic Improvement*:** The integration of modern tools such as genomic selection and marker-assisted breeding with conventional breeding programmes holds immense potential for accelerating genetic improvement in goat populations. Genomic selection allows for the identification of desirable traits at the molecular level, enabling more precise and efficient breeding decisions. Marker-assisted breeding facilitates the selection of individuals with favourable genetic markers associated with target traits, enhancing breeding efficiency and genetic gain. By incorporating these cutting-edge techniques into conventional breeding programmes, we can expedite the genetic improvement process, enhance trait selection accuracy, and develop superior goat varieties tailored to specific production systems and market demands. Moreover, these technologies can aid in the conservation of rare and endangered goat breeds by identifying and preserving valuable genetic traits essential for their long-term survival and productivity.

10. ***Promotion of Collaboration for Data Sharing and Decision-making*:** Collaboration among research institutions, governmental bodies, and farmers is crucial for promoting data sharing and collective decision-making in goat breeding and farming. This collaboration can facilitate the exchange of valuable information, experiences, and best practices among stakeholders, leading to informed decision-making and effective policy

formulation. To promote this collaboration, initiatives should be taken to establish platforms or networks where stakeholders can share data, research findings, and insights. These platforms can also serve as forums for discussion and deliberation on key issues affecting the goat farming sector. By fostering a culture of collaboration and knowledge sharing, stakeholders can collectively address challenges, identify opportunities, and work towards sustainable goat breeding and farming practices.

11. ***Long-term Nature of Breeding Strategies and Genetic Improvement Programmemes:*** Breeding strategies and genetic improvement programmes in goat farming are long-term endeavours that depend on various factors such as support systems, intensity of selection, genetic variation, and management practices. It is essential to recognize and address these factors to ensure the success and sustainability of such programmes. Support systems, including access to veterinary services, extension programmes, and financial assistance, play an important role in enabling farmers to implement breeding strategies effectively. Intensity of selection, which involves the careful selection of breeding stock based on desired traits, requires continuous monitoring and evaluation to achieve desired genetic progress. Genetic variation within populations is important for maintaining diversity and resilience in the face of changing environments and disease pressures. Management practices, such as nutrition, housing, and healthcare, also influence the success of breeding programmes and should be optimized for each breed and production system. By considering these factors and addressing any hurdles that may arise, breeding strategies and genetic improvement programmes can be optimized for long-term success and sustainability in goat farming. Implement comprehensive disease control programmes to manage and mitigate the impact of major goat diseases, ensuring sustained health and productivity improvements.

12. ***Comprehensive Strategy for Controlling Goat Diseases in India*:** A high-priority, multifaceted approach is imperative for controlling goat diseases in India. This encompasses enhanced vaccination programmemes for PPR, Goat Pox, FMD, Brucellosis,

and CCPP, necessitating widespread and regular vaccinations due to significant economic impacts. Improved diagnostic methods, including advanced tools, robust disease surveillance, and regular serosurveys, are essential. Comprehensive disease control programmemes should integrate vaccination, biosecurity measures, and public awareness campaigns, with a focus on collaboration and capacity building. Economic support through subsidies and insurance schemes, coupled with targeted research and development, and public awareness initiatives, will ensure sustainable goat farming practices and mitigate economic losses.

13. ***Research Support*:** Research support should be a cornerstone of livestock policy, requiring sufficient funding, skilled personnel, and advanced infrastructure. This support should enable comprehensive investigations and interventions across various areas. This includes evaluating genetic improvement and selection techniques, utilizing genomic tools for breeding programmes, and managing fertility effectively. Additionally, research should focus on developing intensive bovine production systems, regenerative reproductive technologies, and sexing procedures, as well as producing sexed semen. Understanding the impact of climate change on livestock and developing strategies to mitigate these effects is crucial. Furthermore, research should drive innovations in product processing and technology for goat milk and meat products, ensuring high quality and market competitiveness. Incorporate the evaluation of the economic impact of diseases such as PPR, Goat Pox, FMD, Brucellosis, and CCPP to guide targeted research and policy interventions.

14. ***Reproductive Disorders and the Adoption of AI Technology*:** With the improvement of reproductive efficiency and enhancing genetic diversity, these strategies not only reduce input costs but also promote sustainable agricultural practices. Consequently, these approaches translate into higher productivity and profitability by ensuring healthier herds, optimizing breeding outcomes, and preserving genetic resources. Furthermore, embracing these advancements fosters a more resilient and economically viable goat farming industry, poised for sustained growth and success in the future.

15. ***Capacity Building Programmes and Marketing:*** The education and training on scientific goat farming and data recording systems to ensure the identification of the elite pedigreed animals. Awareness programmes of the consumers/buyers about the quality and nutritional benefits of goat products using various communication tools, social network platforms. Strengthening of marketing infrastructure at different levels is of paramount importance. The government should make a policy to safeguard the small farmers from itinerant traders. There is strong need to develop traceability network for the better marketing of goat products in domestic and international market. Placement of designer RFID for identification and data recording can also serve the purpose to some extent.

16. ***Slaughtering Policy and Processing Infrastructure:*** There is a need to relook into the slaughtering policy and its implementation plans throughout the nation. Strengthening of slaughtering and processing facilities including cold chain is also required for the marketing channels. The strong emphasis is obligatory for the proper utilization of goat industry byproducts for revenue and employment generation, and environment safety.



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ICAR – CIRG Signature



GOAT: A FUTURE ANIMAL

DESCRIPTION OF THE SIGNATURE

- The signature of ICAR - Central Institute for Research on Goats (ICAR-CIRG), Makhdoom, Farah, Mathura UP depicts CIRG in goat model.
- The dot of letter "i" in CIRG proportionately symbolizes goat products, as Red colour for Meat, Brown colour for Hide, Cream colour for fiber and white for milk.
- The logo of ICAR-CIRG is placed in the centre of letter 'R' of signature.
- The water mark in the signature symbolically represents the Laboratory cum Administrative Building of the ICAR-CIRG.
- The tag line Goat: The Future Animal projects goat as better climate adaptability, draught tolerance, better survivability and high market demand.

The Signature of ICAR - Central Institute for Research on Goats (ICAR-CIRG), Makhdoom, Farah, Mathura was designed under the supervision of Dr. Manish K Chatli, Director, by the team of scientists comprising of Dr. Ashok Kumar, Dr. R.V.S. Pawaiya, Dr. A. K. Dixit, Dr. K. Gururaj and Dr. Y. K. Soni.

The Signature was released by Dr. B. N. Tripathi. DDG (AS) ICAR New Delhi on 04-05-2023 in presence of Director. ICAR-CIRG. Dr. M. K. Chatli.

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