KOAN

Challenges in Livestock and Feed Management Practices in India

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Koan Advisory Group is a New Delhi-based public policy consultancy. It specialises in policy and regulatory analysis in both traditional and emergent sectors and markets. For more information, please visit: www.koanadvisory.com

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Table of Contents

List of Figures and Tables

List of Tables

List of Figures

Executive Summary

India leads the world in milk production, contributing 25 percent of the global supply. It also boasts the highest livestock population globally, with over 300 million bovines, including a diverse array of indigenous breeds. However, these breeds often produce less milk compared to buffalos and crossbred cows. In fact, indigenous and nondescript cattle account for only 20 percent of India's total annual milk production. The low milk yield is often linked to challenges in backward linkages, such as poor feed quality, limited fodder availability, and restricted access to essential services like veterinary care and breeding. The lack of robust backward linkages also hampers productivity and revenue for dairy farmers, especially in small and medium-sized farms. Against this backdrop, this study seeks to identify and analyse barriers to India's productivity in dairy farming through four steps. These include (i) an in-depth review of secondary literature, (ii) insights from an expert workshop, (ii) State selection index, and (iv) surveys of farmers and veterinarians.

Technical barriers

1. **Fodder and feed ration balance:** Indian farmers, particularly small and medium-sized, face a shortage of quality certified fodder seeds. The deficit in fodder crop production leads to high fodder prices. While pelleted compounded feed offers comprehensive nutrition as an alternative, it remains relatively expensive due to high demand and limited supply.

2. **Compound feed concentrate, low-cost feed formulation, standards and certification:** The feed given to animals often does not meet their dietary needs, typically falling short while incurring higher costs. To address improper feeding practices, the National Dairy Development Board, supported by the World Bank, developed the Ration Balancing Programme in 2010. This programme includes a ration balancing app, which dairy cooperatives use to formulate total mixed ration (TMR) using locally available fodder and feed ingredients. However, challenges such as low farmer literacy, inadequate skills, limited awareness, high ingredient costs, and insufficient infrastructure for production and storage restrict the use and acceptance of the ration balancing app and TMR.

3. **Animal health, breeding and genetic improvement:** The limited availability of skilled veterinary professionals and sub-par animal healthcare facilities hinder access to veterinary healthcare for Indian dairy farmers, especially in rural areas. The country faces a shortage of veterinarians and para-vets, largely due to the insufficient number of veterinary colleges and courses. As a result, many farmers rely on para-vets for advice and treatment. However, para-vets, primarily trained as livestock supervisors, often lack the necessary training, and are not licensed to treat animals. This situation has led to instances of misdiagnosis, and misuse and overuse of antibiotics, contributing to increased microbial antibiotic resistance. Other persisting challenges include (i) low coverage of artificial insemination (AI), (ii) economic losses due to anoestrus, (iii) poor conception rates, (iv) unregulated AI delivery agencies, (v) extended inter-calving period, (vi) low preference by farmers for raising female calves, (vii) low acceptability of sex sorted semen, (viii) expensive embryo transfer technology, and (ix) poor awareness of feed protocols.

4. **Climate change impact and adaptation measures:** Livestock is a major anthropogenic source of global methane emissions, contributing nearly two-thirds of the global emissions. This puts India at the centre stage to lead efforts in emission reduction and climate change mitigation, given its vast livestock population. For instance, the unabated rise in summer temperatures and extreme heat waves often causes heat stress in livestock. This stress leads to reduced feed intake, decreased milk production, and lower reproductive rates.

   In addition, natural disasters led by climate change have impacted dairy farming. For instance, small and medium-sized farmers in the western and northern regions of India have experienced severe financial setbacks in recent years due to infrastructural damage and livestock losses caused by heavy rainfall and flooding. These events not only undermine the financial stability of these farmers but also disrupt the overall livestock supply chain.

5. **Extension training and capacity building:** Over two-thirds of farmers in India view dairying as a supplementary income source, highlighting the need for robust extension training. However, inadequate funding and limited access to digital tools limit the training opportunities, creating recurrent delays in the implementation of training programmes. In addition, there is a lack of coordination among stakeholders such as State agencies, veterinary universities, central agencies, private companies, non-government organisations, and self-help groups, leading to duplicated efforts and wasted resources.

6. **Availability of farm labour:** Maintaining livestock requires round-the-clock attention, making labour shortages a critical challenge for Indian dairy farmers. Most small dairy farms, dependent on outside labour, struggle to retain workers. This issue is worsened by rising demands for higher wages and benefits from labourers, who often migrate to urban and peri-urban areas. The labour shortage affects daily farm operations, animal health, and productivity.

Stakeholder workshop held on 5th October 2023 at India Habitat Centre, New Delhi

We facilitated a workshop titled “Optimising Animal Nutrition for Enhancing Milk Productivity”, to consolidate insights from 15 sector experts from the government, private sector, research, and academia. The first session of the workshop addressed challenges in fodder, seed production, alternative feed sources, and frameworks for effective multi-stakeholder collaboration. In the second session, experts delved into ration balancing, TMR, and concentrate feed, highlighting the complexities of ration formulation for cattle at various lactation stages. The final session covered strategies for enhancing animal welfare, implementation of preventive healthcare measures, and leveraging technology for monitoring and improving animal health. Experts also emphasised the importance of R&D investments in sustainable dairying methods to reduce the impact of the dairy sector on climate.

State Selection

We developed a comprehensive methodology to select States for intervention by creating the Milk and Feed Productivity Index for Indian States. This index evaluated the performance of 20 Indian States over 37 parameters, aggregating them under four broad pillars: (i) milk production and productivity, (ii) access to veterinary healthcare, (iii) financial allocation and policy support, and (iv) dairy

infrastructure. Based on our analysis and the index, we recommended the four States of Maharashtra, Tamil Nadu, Punjab, and Haryana for detailed field studies involving a sample of livestock farmers and local veterinarians.

Table 1: State selection – overall rank

States	Overall rank	States	Overall rank
Punjab	1	Madhya Pradesh	11
Haryana	2	Telangana	12
Gujarat	3	Tamil Nadu	13
Rajasthan	4	Uttar Pradesh	14
Goa	5	Maharashtra	15
Kerala	6	Bihar	16
Andhra Pradesh	7	Odisha	17
Karnataka	8	West Bengal	18
Uttarakhand	9	Chhattisgarh	19
Himachal Pradesh	10	Jharkhand	20

Maharashtra, one of India's leading milk producers, boasts a renowned dairy cooperative movement called Mahanand Dairy. However, the State faces critical shortages of dry fodder and clean water, leading to low milk productivity in herds owned by farmers. Additionally, Maharashtra has a low veterinarian-to-cattle ratio, less than twenty-eighth of the average of States covered in this study.

Tamil Nadu's largest cooperative, Tamil Nadu Co-operative Milk Producers' Federation, or Aavin, faces tough competition from Amul, a leading dairy brand in India. Key challenges faced by the State include feed sustainability due to the year-round unavailability of green fodder, high costs of cattle feed and mineral mixtures, and a lack of community grazing lands. In addition, cross-bred animals in Tamil Nadu are highly vulnerable to diseases, a problem worsened by knowledge gaps in disease prevention and high medicine costs.

Punjab, the top-ranking State in the State selection index, serves as a benchmark for other northern States in milk production and productivity. However, farmers face challenges in livestock nutrition, including knowledge gaps in balanced feeding practices and high feed costs. High mortality rates in male calves, reproductive disorders, and difficulties in replacing old or disabled cows further complicate the situation.

Haryana faces challenges in veterinary care and feed quality. Challenges include the inconsistent quality and reliability of veterinary healthcare, as well as the high cost of feed inputs like concentrate mixtures. These factors limit revenue generation. The limited adoption of healthcare practices stems from insufficient veterinary services and a shortage of adequately trained technicians.

Survey

We interviewed 150 livestock farmers in the year 2023 across Maharashtra, Tamil Nadu, Punjab, and Haryana to analyse their practices and challenges, and 100 veterinarians in Punjab, Maharashtra, and Tamil Nadu to substantiate the findings.

Maharashtra: In Maharashtra, where fodder shortages are frequent, farmers implement tailored feeding practices at various stages of cattle pregnancy. For example, feed procurement is highly reliant on local markets, and farmers often use personal land for fodder cultivation. Dairy cooperatives in the State contribute to cattle management by providing timely payments and high-quality fodder seeds to farmers enrolled in their programmes.

Tamil Nadu: Farmers in Tamil Nadu show high awareness of TMR, low-cost feeds (LCF), and silage, with veterinarians often recommending hay leaves as feed. However, the adoption rates are inconsistent across farmers. Farmers often use a mixed approach to land utilisation, combining personal and agricultural land for fodder cultivation.

Punjab: Punjab faces prevalent fodder shortages, driving farmers to rely on local markets for feed. However, structured feeding plans for each stage of lactation and strategic planning are helping mitigate feed scarcity. There is a strong endorsement of feed additives and supplements among farmers to improve overall cattle health and productivity.

Haryana: In Haryana, despite the prevalence of traditional feeding methods, there is significant adoption of TMR and LCF. Awareness of silage is limited, and farmers primarily depend on local markets for feed procurement. Farmers in Haryana use personal agricultural spaces for fodder cultivation, with infrequent collaborative land use.

Conclusion

The findings from the survey and the secondary research highlight the need for improving feed provision and management. These include addressing the lack of access to high quality feed, implementing training programmes to educate farmers on advanced feeding practices and promoting the cultivation of diverse fodder plants. Improving their access to organised markets and modernising dairy cooperatives for better discount utilisation will therefore be critical to their success.

In addition, increasing the number of veterinary professionals and mobile veterinary units is much needed to upgrade the overall veterinary health infrastructure. AI technicians need to be regulated and trained better to address reproductive issues and enhance herd performance.

01

Introduction

India is the largest producer of milk globally, and home to a thriving dairy industry with an estimated production of over 230 million tonnes of milk in 2022-23, approximately 25 percent of the world's total milk production (Ministry of Fisheries, Animal Husbandry & Dairying (MoFAHD), 2024). It also has the world's largest livestock population with over 300 million bovines (MoFAHD, 2022). However, India's milk production primarily serves its domestic market, with a small fraction, 156 thousand tonnes of dairy products exported during FY 2022-23 (Kulkarni, 2024).

The country boasts a wide range of indigenous livestock breeds adapted to local climatic conditions and feeding patterns. However, these breeds often have lower milk-yield potential, resulting in a higher carbon footprint and greenhouse gas (GHG) emissions per litre of milk compared to their crossbred and exotic counterparts. Although indigenous breeds have a higher feed conversion efficiency, requiring less feed per unit of milk or meat produced, they also produce more methane per unit of feed consumed than high-yielding foreign breeds. The prevalent low-quality feed and poor feeding practices in many parts of the country exacerbate this issue. Therefore, improving feed quality and implementing practices to reduce methane emissions from indigenous livestock is an urgent need.

Several other factors restrict the growth of the dairy sector in areas including healthcare, breeding, awareness, and training. To explore these challenges, we examined major technical barriers affecting the Indian dairy industry, analysed performance of States, gathered insights from experts, and conducted on-ground surveys with farmers and veterinarians. Based on these findings, we provided recommendations to address these barriers, along with actionable plans and their feasibility for implementation in the Indian dairy industry.

02

Literature Survey

2.1. Production by the masses as opposed to mass-production

In India, the productivity of indigenous and non-descript cattle is significantly lower than buffalos and crossbred cows. For instance, indigenous and non-descript cows contribute only 992 kg of milk per animal per year, while buffaloes yield 2061 kg per animal annually (Department of Animal Husbandry and Dairying (DADH), 2022, PP17). Moreover, the indigenous and non-descript cattle contribute only 20 percent of the total annual milk production with 45 percent being contributed by indigenous/non-descript buffaloes and 30 percent by crossbred cows. The contribution of exotic cows to the annual total milk production stands at a paltry two percent (DAHD, 2023, PP6).

This trend could be linked to low-quality animal feed, as the proportional increase in yield per cow is not realised. For instance, per animal feed input in India is 30 percent lower than the global average of 2,238 kg per year (Deep et al., 2023, PP1). To address the feed and fodder shortage in the country, the Ministry of Agriculture & Farmers' Welfare (MoA&FW) launched the National Livestock Mission (NLM) in the financial year 2014-2015, which includes a sub-mission on feed and fodder development. NLM focuses on areas such as milk production, capacity building, research and development, and job creation.

Despite efforts to improve the Indian dairy sector, challenges in its backward linkages persist. These linkages, which connect farms to input providers like veterinary care, breeding services, and feed suppliers, are largely underdeveloped. While the sector excels in processing and marketing, limited access to these essential inputs leads to poor animal health, low productivity, reduced profitability, and lower farmer incomes.

2.2 Identification of technical barriers

According to the 2019 livestock census, India boasts the world's largest livestock population, with an estimated 535.78 million cattle, including cows, buffaloes, and goats (MoFAHD, 2019). This figure represents a 4.6 percent increase since the 2012 census. During this period between FY 2018-19 and FY 2022-23, milk production surged from 187.30 million tonnes to 230.58 million tonnes (MoFAHD, 2024). Consequently, the per capita availability of milk in India is 459 grams per day, which is significantly higher than the global average of 322 grams per day.

However, India's fodder cultivation does not keep pace with its milk production and the growing human and livestock populations. The country, which houses around 20 percent of the world's livestock and 17.5 percent of the human population, does so on just 2.3 percent of the world's land area. With the human population increasing at 1.6 percent per year and the livestock population growing at 0.66 percent annually, both are competing for limited land resources for food and fodder production. Currently, cultivated fodder occupies only four percent of the country's cultivable land, leading to a

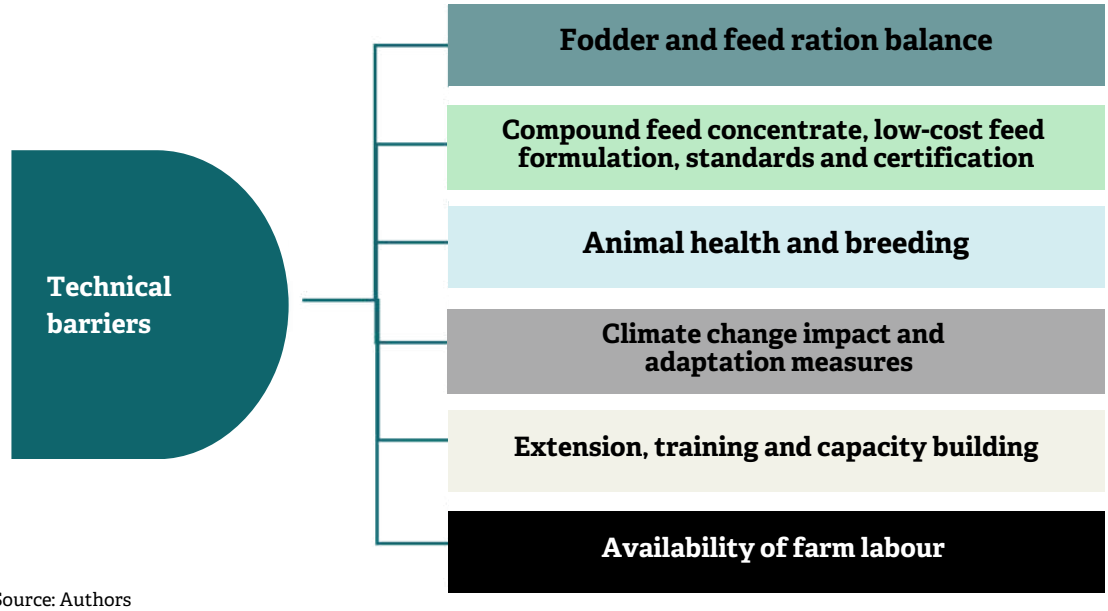
significant shortfall in green fodder, dry crop leftovers, and concentrate feed ingredients (Singh et al., 2022). These challenges highlight the need to identify and address technical barriers to enhance milk productivity while optimising resource use.

India's dairy farming landscape has distinct characteristics that set it apart from Western countries, primarily the US, Canada, and Western Europe. Small and marginal farmers own approximately 60 percent of the female cattle and buffaloes, despite holding only 33 percent of the agricultural land. On average, three-quarters of rural households own between two to four animals, illustrating the widespread integration of dairying within the farming system rather than treating it as a standalone enterprise (Punjabi, 2009). This integration is evident in the use of feed primarily derived from crop residuals.

Dairying accounts for about one-third of rural incomes, highlighting its economic significance. Unlike traditional agriculture, which generates seasonal income, dairying provides a consistent source of income, thereby mitigating income-related risks for farmers. Notably, some evidence suggests that regions with well-developed dairy practices experience fewer instances of farmer suicides (Punjabi, 2009). Additionally, livestock serves as a security asset that can be liquidated during times of crisis, emphasising its multifaceted importance within India's agricultural framework.

Given the socio-economic significance of the dairy industry, we identified six major technical barriers that hinder its development (Figure 1).

Figure 1: Technical barriers in cattle and feedstock management



Source: Authors

To pinpoint these barriers, we reviewed secondary literature and engaged with external experts and key stakeholders in the animal nutrition sector. The following sections delve into our research strategy and discuss the technical barriers in greater detail.

03

Research Strategy

The study adopts a three-pronged research strategy following the identification of technical barriers. This includes an expert workshop covering themes under the identified technical barriers, a State selection index to classify and rank Indian States based on various dairy industry-linked parameters, and a farmer and veterinarian survey in target regions identified through the State selection exercise.

3.1 Expert workshop on technical barriers

We conducted an expert workshop to facilitate knowledge sharing and encourage participants to brainstorm potential solutions and develop collaborative interventions for the identified technical barriers in the Indian dairy sector. The workshop, themed, Optimising Animal Nutrition for Enhancing Milk Productivity, brought together relevant experts, practitioners, and stakeholders from the dairy industry. Participants included private professionals, scientists, and veterinarians with diverse backgrounds in animal nutrition, veterinary science, agriculture, and sustainability. The outcomes and insights from the workshop are integrated in Chapter 4 and 5 of this report.

3.2 State selection

As part of the study, we developed a comprehensive methodology to select States by creating the 'Milk and Feed Productivity Index' for Indian States. This index aims to identify gaps, evaluate the performance of Indian States, and shortlist them for further investigation across thematic areas and eventual on-ground programmatic interventions. To achieve this, we collated data from multiple secondary sources across 20 States and over 37 parameters, aggregating them under four broad pillars: (i) milk production and productivity, (ii) access to veterinary healthcare, (iii) financial allocation and policy support, and (iv) dairy infrastructure. Based on our analysis and the index, we recommend the four States of Maharashtra, Tamil Nadu, Punjab, and Haryana for detailed field studies involving a sample of livestock farmers and local veterinarians. Detailed State rankings and analysis are presented in Chapter 6.

3.3 Farmer and veterinarian survey

The final phase of the study involves surveying and conducting detailed interviews with 30 veterinarians across the four selected States, including participants from both the public and private sectors. It provides deeper insights into the technical barriers related to adopting accessible and affordable nutrition practices, particularly those affecting smallholder farmers. We surveyed 50 farmers to understand their challenges in areas such as feed and fodder procurement, profitability, animal breeding, and management. This analysis enabled us to identify and compile a list of potential interventions, setting the stage for future initiatives in the target regions.

04

Technical Barriers

We discuss the technical barriers specific to the growth of the Indian dairy sector, based on the findings from secondary research, validated by interviews with ecosystem stakeholders.

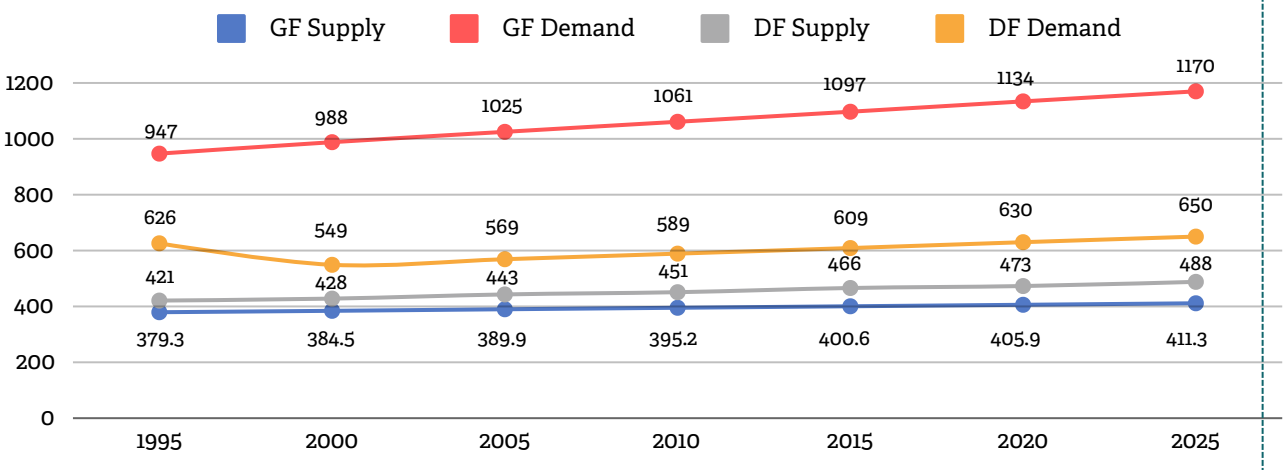
4.1 Technical barrier 1: Fodder and feed ration balance

4.1.1 Shortfall of quality and certified fodder seeds and crops

The availability of quality and certified fodder seeds is a significant challenge for Indian farmers – a key barrier to country's dairy sector growth. Although the Central Fodder Seed Production Farm (CFSPF) in Bangalore, a government initiative, along with various national and State seed corporations, produces certified fodder seeds, most of these seeds are consumed by local farmer producer organisations (FPOs), non-government organisations (NGOs), dairy cooperatives, and private farms. As a result, small and medium-sized farmers are left with an unmet demand for essential seeds. Due to limited access and unequal distribution, these farmers are often forced to rely on seeds from previous harvests or procure them from neighbouring farms. The shortage of required fodder seeds is estimated to be as high as 70-75 percent, with the deficit in essential range grasses and legumes reaching about 90 percent.

In addition to the fodder seed shortage, India has consistently faced substantial deficits in the production of essential fodder crops over the past two decades. Currently, the country faces deficits of 11.24 percent in green fodder, 23.4 percent in dry fodder, and 28.9 percent in feed concentrates (Indian Council for Agricultural Research (ICAR) – Indian Grassland and Fodder Research Institute (IGFRI), 2022). According to the Indian Grassland and Fodder Research Institute (IGFRI), this shortage is expected to widen if corrective measures are not adopted (Down To Earth, 2016). Figure 2 depicts the slow growth of fodder supply relative to demand, further widening the fodder deficit by 2025.

Figure 2: Fodder demand and supply projection 2025



GF: Green fodder, DF: Dry fodder; Source: IGFRI Vision, 2030

There is considerable variation in national fodder deficit estimates. A recent study suggests a net shortfall of 35.6 percent in green fodder, significantly higher than the previously reported 11.24 percent (Sharma and Choudhary, 2023). Currently, the Ministry of Agriculture & Farmers' Welfare (MoA&FW) does not collect data on fodder crops, leading to a lack of reliable information on fodder production. According to the IGFRI, precise data on fodder crop production, yield, and the adoption of improved varieties and technology is unavailable. The absence of a dedicated agency to monitor these aspects hinders effective policy formulation and research planning for fodder development and cultivation.

4.1.2 High prices of compounded cattle feed

Pelleted feeds with varying protein levels are the most commonly used form of compounded feed across India. This is more prominent in southern India, where dairy federations use and distribute compounded feed to meet the nutritional needs of cows and buffaloes. Unlike feed mixes that allow animals to browse and selectively consume ingredients, pelleted compounded feeds provide complete nutrition, ensuring high feed efficiency, judicious use of feed, and reduced wastage.

However, price is a significant barrier to the adoption of compounded feeds, making them unaffordable for small and medium-sized farmers. This is primarily due to a shortfall in the availability of compounded feed, estimated at 28.9 percent of overall demand, and overheads such as volatile commodity prices, manufacturing costs, and transportation. Dairy cooperatives in Karnataka have attempted to mitigate this issue by offering a 25 percent discount on pellet prices. They achieve this by limiting their profit margins to five percent, compared to the 20 percent retained by private feed companies, and cross-subsidising costs from profits made through the sale of value-added milk products.

To address the fodder shortfall, the government and public actors are promoting the use of contingency feed or alternative sources. These include silage from maize stover, mustard/soybean straws, banana stems, hydroponically produced sprouts, azolla, and tree leaves. Crops such as sorghum, which are climate-resilient, have low seed requirements, high biomass and digestibility, and provide better yields than other widely adopted fodder crops, are also recommended as excellent alternative feed sources on a large scale.

Researchers and policymakers suggest that contract farming could be a potential solution to these challenges, with some successful initiatives implemented by milk federations in south India. However, such initiatives remain relatively scarce. The private sector has shown little interest in producing fodder seeds due to their low remunerative potential and the absence of market frameworks. Consequently, private sector inventories are primarily managed against advance orders from farmers.

4.1.3 Promotion of bypass protein use

Another promising solution to the fodder issue is promoting the use of bypass proteins. The Indian Government has launched initiatives under NLM to standardise and promote the use of commercial bypass proteins, such as seed meals, to improve the availability of protein and essential amino acids in cattle feed. These initiatives aim to dissuade farmers from using inferior quality feed resources with degradable protein and include appropriate training and extension interventions.

Bypass proteins, including cost-effective and abundantly available cottonseed extract, are being used as substitutes for pricier and relatively scarce commodities like groundnut oil cake, with positive

outcomes. A few private companies have started incorporating bypass proteins into their special feed formulations, particularly for high-yielding exotic cows. The use of these alternatives has shown potential to enhance milk production and reduce methane emissions.

For instance, efforts to replace approximately 50 percent of groundnut cake in a farmer's feeding practice with cottonseed extract, a bypass protein, for lactating animals resulted in an increase in milk yields by 1.2-1.7 litres per cow per day. This transition also reduced feed costs by ₹0.81 to ₹3.90 and increased the farmer's income by approximately ₹15.80 to ₹17.81 per cow per day (Kolte et al., 2012, PP42).

4.2 Technical barrier 2: Compound feed concentrate, low-cost feed formulation, standards and certification

4.2.1 Ration balance and Ration Balance Programme

Farmers often rely on traditional knowledge passed down through generations to feed their livestock. They use resources such as crop residues and locally available feed components like brans, oil cakes, chunnies, grains, and seasonally accessible green forage. Occasionally, they provide mineral supplements to their animals, typically in small amounts ranging from 25g to 50g per day (National Dairy Development Board (NDDB), 2022). However, the quantity of feed or forage given to animals often does not align with their actual dietary needs, usually falling short of the required amount while still incurring higher costs. Table 2 depicts the average feeding trends in India.

Table 2: Average feeding trends in India

Diet components	Actual requirement			Farmer's practice			Additional expenses incurred daily (₹)
	Kgs.	Dry matter received	Cost (₹)	Kgs.	Dry matter received	Cost (₹)	
Green fodder	40	8	60	15	3	22.5	92.5
Dry fodder	3	3	30	4	4	40	
Cattle feed/concentrate	6	5.4	180	10	10	300	
Total	49	16.4	270	29	17	362.5	

Source: Stakeholder Workshop, 2023

Assumptions: milking animal with an output of 20 litre/day; feed requirements calculated on assumed body weight of 450-500 kg, prices per kg - green fodder: ₹1.5; dry fodder: ₹10; cattle feed/concentrate: ₹30

To address the issue of improper feeding practices, the National Dairy Development Board (NDDB) introduced the Ration Balancing Programme (RBP) in 2010, and subsequently developed a Ration Balance app in 2015. This app is used by dairy cooperatives to formulate total mix ration (TMR) using available fodder and feed ingredients from the local market. Currently, NDDB supported RBP is underway in Kolhapur. This initiative, in collaboration with the district milk cooperative, covers 200 villages, 20,000 milch animals including cows and buffaloes, and 7,000 farmers.

The app is widely used for creating nutritionally balanced animal rations based on the in-built nutritional profiles of over 200 locally available feeds and feed ingredients. It is particularly valuable for farmers in developing low-cost feed (LCF) formulations. The RBP, supported by the World Bank, aims to demonstrate and train dairy farmers in using the Ration Balance app to improve milk production.

Despite the extensive and successful trials carried out across the country, several challenges persist in implementing the programme (Sirohi et al., 2017):

- Being a farm advisory programme, the RBP is challenging to implement with low levels of farmer literacy.
- Dairy cooperatives struggle to afford the salaries of facilitators, such as local resource persons, who work with farmers to formulate and prepare rations.
- Procuring high-quality feed ingredients as per formulation from the local market is complicated because feed ingredient standards developed by the Bureau of Indian Standards are not mandatory, and the ingredients may not conform to quality standards.
- Lack of motivation among farmers reduces the likelihood of interactions with RBP advisors.

4.2.2 Total mix ration (TMR) – conventional and dry

Developed nations have widely adopted the TMR method for feeding dairy cattle since 1950s. TMR ensures that all necessary nutrients are present in the right proportion for optimum milk production, animal health, and reproduction. NDDB is successfully conducting trials and pilot studies with conventional TMR and dry TMR in select parts of the country in collaboration with local milk unions.

In the conventional TMR approach, chopped green fodder or silage is combined with cereals, cereal by-products, protein sources, minerals, vitamins, and feed additives to provide a well-balanced diet for dairy animals. However, in India's prevalent smallholder dairy production systems, a TMR based on crop residues, known as dry TMR, proves more suitable. This form can be conveniently transported and stored for at least 2-3 weeks, unlike conventional TMR.

Despite the success of these trials, a study by Sirohi et al. (2017) identified several challenges in implementing TMR:

- Acceptance and adoption in remote areas are limited due to a lack of knowledge and awareness about TMR among farmers.
- Making quality TMR can be challenging in areas with limited access to feed sources, connectivity issues, and price fluctuations, as it requires a consistent and adequate supply of quality ingredients.
- The cost of some ingredients in TMR formulation can be high, deterring farmers from adopting TMR as their main feed strategy.
- Limited infrastructure, such as mixing machines and storage, along with a lack of reliable extension services, knowledge sharing, and training, hinders widespread adoption.

4.2.3 Limitations with community feeding models

Inadequate governance structures frequently diminish community organisations, such as dairy cooperatives, to entities that lack genuine community engagement. These governance challenges have

widespread effects throughout the entire system, from State federations to village societies, greatly influencing farmer participation (Punjabi, 2009). Furthermore, community feeding models encounter numerous limitations:

- The scope of ongoing pilots by the NDDB is limited in terms of farmer coverage and the number of districts covered, with restricted sharing of trial outcomes and information.
- Pilots evaluating the benefits of community feeding models, conducted in association with self-help groups (SHGs) and FPOs, are selective and involve only member farmers of cooperatives, communities, and groups, excluding a large number of non-members.
- The diversity of livestock species command diverse nutritional needs, making it difficult to develop a universal feed model.
- Only about four percent FPOs in the country are actively involved in significant economic activities, limiting their role unless their inherent problems are addressed for future scalability, replicability, and sustainability.
- According to Dr Kamat of the Kolhapur district milk union, significant investments in infrastructure for TMR manufacture are challenging, as most dairy farmer cooperatives lack funds and require financial support in the form of subsidies or grants. Without such support, these investments would drive up feed costs, making them unaffordable for small farmers.

4.3 Technical barrier 3: Animal health, breeding and genetic improvement

Animal health, breeding, and genetic improvement play a crucial role in milk production and productivity. Persisting challenges include: (i) shortage of skilled veterinary professionals and poor animal health care facilities, (ii) inadequacies in breeding and genetic improvement programmes, (iii) low coverage of artificial insemination (AI), (iv) economic losses due to anoestrus, (v) poor conception rates, (vi) unregulated AI delivery agencies, (vii) extended inter-calving period, (viii) low preference by farmers for raising female calves, (ix) low acceptability of sex-sorted semen (SSS), (x) expensive embryo transfer technology (ETT), and (xi) poor awareness of feed protocols.

4.3.1 Shortages of skilled veterinary professionals and poor animal health care facilities

Indian dairy farmers face considerable challenges in accessing veterinary health care services, especially in remote rural areas. Limited availability of skilled veterinary professionals and sub-par animal health care facilities exacerbate these issues. For example, the country faces a significant shortage of veterinarians and para-vets, with deficits of 22.65 percent and 29.60 percent, respectively, as reported by the Standing Committee on Agriculture, Animal Husbandry, and Food Processing for 2022-23. As of March 31, 2023, the Veterinary Council of India (VCI) listed 89,000 registered veterinarians, falling short of the required 1,20,000, highlighting a 26 percent gap. This shortage was confirmed by Dr V. Ksheersagar, former Managing Director of Pune District Milk Union, and Dr D. Parkale, Additional Commissioner, Department Of Animal Husbandry and Dairying (DAHD), Maharashtra.

The shortage of veterinary graduates is attributed to the insufficient number of veterinary colleges and the absence of diploma and intermediary-level programmes, including nursing cadres. These shortages have particularly impacted vaccination drives and caused delays in animal care, leading many farmers to seek advice and treatment from para-vets. However, para-vets often lack extensive training and are primarily trained as livestock supervisors, not licensed to treat animals. This has led

to instances of misdiagnosis, misuse, and excessive use of antibiotics, contributing to increased microbial antibiotic resistance. Additionally, the sale of questionable drugs by unscrupulous individuals exacerbates the issue. Grey marketing and profiteering in critical drugs further raise costs, making healthcare services unaffordable for many small and medium dairy farmers. Consequently, Indian dairy farmers suffer direct losses exceeding ₹50,000 crores annually (Audarya, 2020).

In response, the government launched the National Animal Disease Control Programme (NADCP) with a financial outlay of ₹13,343 crores for 2019 to 2024 (Ministry of Environment, Forest and Climate Change (MoEFCC), 2021). Similarly, DAHD allocated ₹682.37 crore to 34 States and Union Territories (UTs) for the procurement of 4,340 mobile veterinary units (MVUs) to enhance access to veterinary services at farmers' doorsteps. However, these schemes have been less than successful due to ongoing shortages of veterinarians and MVUs, coupled with poorly equipped medical diagnostics.

4.3.2 Inadequacies in breeding and the genetic improvement programme

The success of the Indian dairy industry over the years is largely attributed to the increasing number of milch animals rather than productivity improvements. With growing shortages of feed and fodder, enhancing milk production now relies on improving animal productivity. This requires the genetic enhancement of low-yielding indigenous breeds through advanced breeding methods such as AI, ETT, and SSS. However, several key barriers impede the effective rollout of these breeding and genetic improvement programmes. These include:

Low coverage of AI: AI helps enhance herd performance by using genetically superior sires and reducing sexually transmitted diseases. Despite its benefits, the current AI coverage in bovines in India, which includes cattle and buffaloes, is only 30 percent, with a conception rate of 35 percent, compared to the government's target of 50 percent (NAAS, 2020). Key reasons for low AI coverage include (a) challenges in timely AI delivery; (b) inadequate mechanisms to ensure semen procurement from certified stations; (c) non-adherence to standard breeding policies; (d) lack of mandatory animal identification and data retrieval systems; (e) high inter-calving intervals; and (f) inadequate AI training and technician control.

Economic losses due to anoestrus: Anoestrus, a condition of infertility in dairy animals, poses significant economic challenges. A study in Punjab estimated losses due to anoestrus at ₹2,135.79 crore (Malik et al., 2021). Crossbred cattle and buffaloes experience higher mean economic losses per animal per year due to milk yield loss, animal replacement costs, future calf reduction, and veterinary expenses. Poor farmer awareness of heat detection practices, shortages of veterinarians, and lack of preventive and therapeutic measures exacerbate the problem.

Poor conception rates: Poor conception rates are a significant challenge, attributed to: (a) low number of accredited AI training centres; (b) inadequately trained skilled forces; (c) non-compliance with minimum standard protocols by AI practitioners; (d) low reproductive efficiency in cattle; (e) conditions like anoestrus and reproductive failures; (f) early embryonic death; and (g) repeat breeding and abortions.

While some AI technicians are trained and certified, a significant number lack formal training and qualifications. The use of low-quality semen also undermines the success of AI programs. Although state governments have traditionally offered free or subsidised animal health and breeding services, inadequate veterinary infrastructure and limited funding significantly reduce their effectiveness.

Some States have introduced partial or full-cost recovery models, which remain unaffordable for small and marginal farmers. Cooperative milk unions, NGOs like BAIF and JK Trust, and private-sector AI technicians also provide these services for a fee. According to the National Academy of Agricultural Sciences (NAAS), only 30 percent of breedable animals receive AI services, a statistic confirmed by Dr Jayant Khadse, Director of Research at BAIF, as well as Dr Kamat and Dr V. D. Patil from the Kolhapur District Cooperative Milk Producers Union. Many farmers resort to using undertrained AI workers who charge lower fees but often disregard standard procedures and State breeding policies, with the lack of proper record-keeping further aggravating the issue.

Unregulated AI delivery agencies: Poor regulation of AI delivery agencies leads to overlapping semen distribution and indiscriminate insemination, raising concerns about the accuracy and accessibility of breeding information. Lax licensing and registration of AI workers with specific State or national agencies exacerbate the issue.

Extended inter-calving period: Extended inter-calving periods decrease the number of calves an animal can produce in its lifetime and reduce total milk production. This is especially problematic in buffaloes, leading to the culling of animals for economic savings.

Low preference among farmers for raising female calves: Many farmers neglect or give less attention to raising calves, leading to high early calf mortality and reduced replacement stock in herds. This results in genetic loss and reduced genetic gains. This was corroborated during discussions with Dr Dinesh Bhosale of AB Vista South Asia, who emphasised the importance of calf survivability for both breeding and economic reasons.

Low acceptability of SSS: Small and marginal farmers often lack awareness or acknowledgement of the benefits of SSS, which can help avoid raising male calves and enhance genetic improvements.

Expensive ETT: ETT is unaffordable for most small and marginal farmers, hindering the faster spread of high-pedigree progeny through genetic selection.

4.3.3 Lack of awareness on feed protocols

The lack of awareness about modern feeding protocols, including the concepts of complete feed ration, ration balancing, and the importance of feed supplements like essential minerals and trace elements, significantly impacts conception rates and reproductive performance in dairy cattle. It is crucial for dairy farmers to understand the critical role that proper feed protocols play in enhancing productivity and milk production. Dr Paresh Pandya, Head of the Centre for Excellence at Kamdhenu University in Anand, Gujarat, validated the same. He observed that due to limited knowledge of feeding protocols, farmers often rely on basic thumb rules linked to milk production, such as providing 300 to 400 grams of concentrate per litre of milk, along with occasional maintenance supplements. While these methods may suffice for low-yielding cows, they are inadequate for achieving higher yields. Educating farmers about modern feeding techniques is crucial for enhancing the health and productivity of dairy herds.

4.4 Technical barrier 4: Climate change impact and adaptation measures

Climate change poses a significant challenge to Indian livestock farming. Simultaneously, enteric methane emissions from livestock digestive processes contribute to nearly two-thirds of global

agricultural methane emissions (Kuhla & Viereck, 2022). Given that livestock is a major anthropogenic source of methane emissions, India's substantial and growing livestock population significantly contributes to GHG emissions (Bhatta, 2023). Therefore, while the dairy production ecosystem is sensitive to climate change, it also plays a major role in exacerbating the phenomenon.

Increasing ambient temperatures and frequent extreme weather events, such as floods and heatwaves, disrupt the supply of water and fodder, leading to scarcity and poor-quality feed. This results in a decline in milk productivity and reproductive performance. The multifaceted effects of climate change on Indian livestock farming are deeply concerning, threatening farmers' livelihoods and risking negative economic implications for the industry's overall sustainability.

4.4.1 Heat stress and reduced productivity

The unabated rise in summer temperatures and extreme heat waves cause heat stress in livestock. This stress leads to reduced feed intake, decreased milk production, and lower reproductive rates. The physiological impact of heat stress affects the overall productivity of the livestock industry, resulting in financial losses for farmers. Upadhyay et al. (2009) reported that annual milk loss due to thermal stress in India was 1.8 million tonnes, or approximately two percent of the country's total milk production, amounting to a staggering ₹2,661.62 crores per year. Additionally, heat stress has led to an increase in tick infestations among livestock, with global economic losses estimated between USD 14,000–18,000 million, or, approximately ₹1,16,200 - 1,49,400 crores. Indian farmers have faced losses amounting to USD 498.7 million, or, over ₹4,000 crores (Singh and Rath, 2013). These infestations exacerbate the economic challenges faced by Indian livestock farmers.

4.4.2 Economic impact and burden on livestock farmers

Small and medium-sized farmers in the western and northern regions of India have experienced severe financial setbacks in recent years due to infrastructural damage and livestock losses caused by heavy rainfall and flooding. These events not only undermine the financial stability of these farmers but also disrupt the overall livestock supply chain.

The cumulative impact of climate change on Indian livestock farmers is profound. Reduced productivity, increased healthcare costs, and financial losses due to extreme weather events and other climate-related challenges make it increasingly difficult for farmers to invest in improved livestock management practices. Additionally, climate change-induced crop failures and reduced fodder availability have led to higher feed prices, further burdening farmers with increased production costs. This, in turn, compounds the economic hardships faced by the Indian livestock farming community.

4.4.3 Methane and heat stress mitigation strategies

To counter the adverse effects of climate change on animal production and health in India, substantial improvements in nutritional management practices are crucial. Experts have identified several strategies as potential solutions (Figure 3):

Improving rumen efficiency: Nutritional technologies aimed at enhancing rumen efficiency and dietary manipulation have shown promising results. However, these techniques need further validation and scaling to make a significant impact on livestock farming. The ICAR-Outreach Programme, for example, has focused on estimating methane emissions under various feeding

systems and developing mitigation strategies. One notable approach involves incorporating Padina Gymnospora bio-waste into diets. This biowaste, rich in terpenoids, essential oils, flavonoids, sterols, and polyphenols, has demonstrated the potential to reduce methane production by 30 to 41 percent.

Figure 3: Enteric methane emissions inhibition strategies

Dietary manipulation	Management	Rumen manipulation
• Concentrate diet proportion • Concentrate diet type • Increase forage digestibility • Include leguminous fodder • Molasses/Urea Molasses Mineral Block (UMMB) • Include Fats/oils • Include additives like tannins, saponins, ionophore, propionate enhancers, essential oils, and direct inhibitors.	• Reduce number of animals • Increase forage quality • Increase animal productivity • Increase efficiency/less Residual Feed Intake (RFI) • Exercise better grazing management	• Genetic engineering • Defaunation • Antibiotics bacteriocin • Vaccines • Acetogens • Probiotics • Archaeal viruses • Methane oxidizers

Source: Stakeholder workshop, 2023

Addressing heat stress: Rising ambient temperatures due to climate change can cause heat stress in livestock. Nutritional interventions are key to managing this issue. These may include the use of antioxidant minerals, vitamins, herbal compounds, and other beneficial molecules to mitigate the effects of heat stress on animal health. Alongside nutritional measures, effective management practices are essential to protect animals during extreme heat events.

Feeding management during droughts and floods: Technological solutions to manage animal feeding during droughts and floods need reinforcement. Ensuring that livestock have access to proper nutrition during such climatic challenges is critical. Effective management practices during these calamities are essential for safeguarding the well-being of dairy animals and protecting the livelihoods of farmers.

4.5 Technical barrier 5: Extension training and capacity building

Efficient extension services are crucial for addressing the diverse needs of dairy farmers in India, especially since many continue to rely on traditional practices despite efforts to modernise the sector. A study by Jaiswal et al. (2018) highlights that approximately 69 percent of farmers view dairying as a supplementary source of income, emphasising the importance of effective extension services in the dairy industry.

One major issue is the recurrent delay in implementing training systems based on new research findings. These systems often recommend the use of locally available feeds and ingredients, which could significantly improve dairy farming practices. However, this valuable knowledge is frequently overlooked or inadequately promoted, with bureaucratic constraints and funding shortages often confining impactful research to the laboratory.

Customised training and extension programs are essential for addressing specific challenges faced by farmers, such as livestock health, breeding, nutrition, and farm management. Extension workers, who are key to delivering these services, often lack access to up-to-date information resources, limiting their useful impact. Dr Kumbhar from the Vijayapura and Bagalkot Milk Union advocates for increasing the number of training sessions from one to three per year per farmer, reflecting the need for more frequent and comprehensive engagement.

Coordination among extension workers from various entities—including State agencies, veterinary universities, central agencies, private companies, NGOs, and self-help groups—often falls short. This lack of coordination leads to duplicated efforts and wasted resources, which could be mitigated through better collaboration and planning. Effective communication in regional or local languages is crucial, and all training materials should be prepared and shared in these languages to ensure successful training delivery.

Additionally, extension services face challenges such as inadequate funding, a shortage of trained personnel, and limited access to modern tools like digitisation. These constraints restrict the scale and quality of services provided, further impeding efforts to enhance dairy farming practices.

4.6 Technical barrier 6: Availability of farm labour

Labour is a crucial resource in effective farm management and holds significant financial importance within the dairy sector in India. Labour costs account for approximately 15-20 percent of the total cost of milk production, making it the second largest expense after animal feed, which constitutes about 60-70 percent of production costs (Team Pashudhan Praharee, 2020). This highlights the critical role that labour plays in dairy farming, especially given the traditional, manual, and physically demanding practices that are prevalent in the industry.

Maintaining livestock requires round-the-clock attention, and labour shortages have become a critical challenge for Indian dairy farmers. Many small dairy farms, which rely on labour from outside the family, struggle to retain workers. This issue is exacerbated by the rising demand for higher wages and benefits from labourers, who often migrate to urban and peri-urban areas. The competition for skilled and reliable workers intensifies the problem, particularly during essential periods such as calving, milking, and feeding.

Rural to urban migration has left farmers in need of dependable labour to care for animals, manage routine tasks, and perform essential activities like land preparation, cleaning, and constructing animal shelters. This labour shortage affects the daily operations of dairy farms and limits the execution of critical activities, ultimately impacting animal health, productivity, and the overall economics of farming. Small and marginal farmers, in particular, feel the strain as they struggle to meet the increasing wage demands of labourers.

05

Stakeholder Workshop

On October 5, 2023, we hosted a multistakeholder workshop titled '**Optimising Animal Nutrition for Enhancing Milk Productivity**' in New Delhi. The workshop aimed to provide actionable insights for improving milk productivity through enhanced animal nutrition strategies. It brought together 15 dairy sector experts from the government, private sector, research, and academia.

Dr Abhinav Gaurav from the Environmental Defense Fund delivered an insightful keynote address, emphasising the critical role of nutrition in enhancing milk productivity and the need for innovative approaches to optimise animal feed formulations.

The first session focused on challenges related to fodder, seed production, and alternative feed sources. Experts shared research findings and insights from their animal nutrition programmes, discussed predictive models for fodder production, and explored best practices for producing alternative feed sources. They also identified frameworks for multi-stakeholder collaboration.

The second session covered ration balancing, TMR, and concentrate feed. Experts highlighted the complexities of formulating rations to meet cows' nutritional needs at different lactation stages and production levels. Discussions included forage quality, concentrate feeds, and the impact of environmental factors on ration composition.

The final session focused on animal health, milk production, breeding, genetics, and reproductive technologies. Experts discussed strategies for enhancing animal welfare, preventive healthcare measures, and the role of technology in monitoring and improving animal health. Experts also highlighted challenges including disease management, nutrition-related health issues, and the impact of stress on milk yield. It concluded with discussions on the impact of climate change on dairy farming practices, emphasising the need for R&D investments in sustainable dairying methods. The workshop provided a collaborative platform for dairy sector experts to share knowledge and explore innovative solutions for optimising animal nutrition and enhancing milk productivity.


WORKSHOP ON
OPTIMIZING ANIMAL
NUTRITION FOR ENHANCING
MILK PRODUCTIVITY


WORKSHOP ON

06

State Selection: Milk and Feed Productivity Index

This exercise involves the identification of relevant States for on-ground programmatic interventions in the area of animal nutrition. It categorises and ranks States based on their existing capacity and potential ability to scale practices across nutrition, feed and feed management.

Against this background, we developed a comprehensive **'milk feed and productivity index'** as a decision support tool to realise the above-mentioned objectives.

The index considers best practices in milk production and necessary enabling environments. These include access to veterinary healthcare, policy support, effective feed management, and the adoption of modern technology in milk processing. Through this index, we identified the best-performing States across the animal nutrition sector and ranked them across success indicators directly linked to feed and nutrition. The outputs from this benchmarking exercise act as signalling instruments for the validation of our primary, secondary research findings. These also help us in collecting insights on the technical barriers that limit the growth of the Indian dairy industry.

6.1 Objectives

We intend to achieve four objectives through the State Selection exercise:

1. Evaluate and compare the performance of Indian States;
2. Identify States with systemic gaps;
3. Use the findings from the index to validate insights obtained from secondary and subsequent primary research envisaged with farmers and veterinarians;
4. Shortlist regions warranting further investigation across thematic areas and eventual on-ground programmatic interventions.

6.2 Overview

The findings from this index provide valuable insights for practitioners in the development sector and other stakeholders. It offers a contextual understanding of a State's performance within the animal nutrition landscape and compares it with best-performing States. The index pinpoints specific gaps based on the parameters covered to support further action, including on-ground interventions.

While our research utilises the latest reliable datasets, there are instances of missing data for certain States. To address this issue, we have employed statistical techniques to approximate the missing values. The details of these techniques are included as part of the methodology. It is important to note that the index does not comprehensively cover data on the private sector in access to veterinary healthcare and dairy infrastructure. Such information is not readily available in the public domain for all States. In such cases, we have supplemented the index with insights gathered from additional

reports to fill information gaps. Moreover, to ensure the authenticity of our results, we have deliberately excluded sources with unreliable data, even if it meant covering a smaller number of parameters.

6.2.1 Approach

We gathered secondary data for 20 Indian States from publicly available sources, listed in Table 1 to compare their relative performance in the dairy ecosystem. The exercise involved assessing 37 parameters for the selected States, grouped into four components: (i) milk production and productivity, (ii) access to veterinary healthcare, (ii) financial allocation and policy support, and (iv) dairy infrastructure. We used these data sources to construct an index that evaluates the performance of the dairy sector for all States. All four components of the index examine distinctive aspects of the dairy ecosystem:

1. **Milk production and productivity**: This component evaluates the milk production and productivity levels of different States. It combines parameters that assign scores based on factors like volume of milk production, population density of milching animals and average milk yield. This exercise considers high productivity as a progressive indicator for a State's dairy industry.
2. **Access to veterinary healthcare**: This component examines the availability and accessibility of government-owned veterinary healthcare services. It includes the number of veterinary hospitals and dispensaries, veterinary professionals per livestock population, vaccination coverage by veterinary institutions, disease control measures, and State support for animal health and welfare. States with denser veterinary healthcare infrastructure tend to have healthier livestock populations and are expected to face a minimum dip in productivity in instances of disease outbreaks.
3. **Financial allocation and policy support**: This component analyses the financial allocation and policy measures implemented by State governments to support the dairy sector. Parameters include budget allocation for dairy development, subsidy programmes, support to dairy cooperatives and farmer memberships under support programmes. States with higher financial allocation and activity in support programmes tend to have a more conducive environment for dairy sector development.
4. **Dairy infrastructure**: This component assesses the existence of critical infrastructure available for dairy production, processing, and marketing. Parameters include the number of dairy plants, milk coolers, processing units and market linkages. States with well-developed dairy infrastructure can better handle milk procurement, processing and distribution, as well as mitigate risks associated with supply chain disruptions.

Table 3: States listed for the Index

Andhra Pradesh	Haryana	Maharashtra	Tamil Nadu
Bihar	Jharkhand	Himachal Pradesh	Telangana
Chhattisgarh	Karnataka	Odisha	Uttar Pradesh
Goa	Kerala	Punjab	Uttarakhand
Gujarat	Madhya Pradesh	Rajasthan	West Bengal

Source: Authors

6.3 Methodology

We used secondary data sourced from annual reports available on government-owned websites, scientific journals and press releases by relevant ministries to construct the index. Key parameters are listed in Table 4. To ensure relevance, we've considered the most recently available values.

- We use 740 observations in the dataset, spread across 37 parameters, with 10 instances of missing values. To estimate these missing values, we extrapolated the mean of the values across the neighbouring States that share a border and exhibit similar geographic characteristics.
- To achieve consistency and comparability, we transformed all continuous variables to a ratio scale using normalising variables such as the number of milching animals, human population, and milk production. Consequently, we rescaled all variables to a range between 10 and 100. We have expressed parameters in different units and scales, as the rescaling process reduces excessive differences i.e., heterogeneity, between variables while preserving the inherent inter-state variability.
- The statistical method employed for aggregating the parameters is principal component analysis (PCA). PCA involves projecting the parameters onto a reduced number of dimensions, known as principal components, with a higher emphasis placed on those parameters that exhibit the greatest discriminatory power among the States.

We have set the weightage for the '**production and productivity**' component at 40 percent, given the focus of the study on feed and productivity. For the remaining 60 percent of the index, we have evenly distributed the weight among the other three components.

Table 4: Parameters and sub-indices listed for the Index

Pillars	Parameters
Milk production and productivity	Milk production per 1000 milching animals
	Number of animals in-milk of exotic/crossbred cows per million human population
	Average yield per in-milk animal of exotic/crossbred cows
	Number of animals in-milk of nondescript/indigenous cows per million human population
	Average yield per in-milk animal of non-descript/indigenous cows
	Number of animals in-milk of buffaloes per million human population
	Average yield per in-milk animal from buffaloes
	Number of animals in-milk of goats per million human population
	Average yield per in-milk animal of goats
	Per capita availability of milk
	Value of output for milk group per 1000 milching animals

	Supply demand ratio for dry fodder
	Supply demand ratio for green fodder
	Emission intensity (emissions per 1000 litres of milk production)
Access to veterinary healthcare	Veterinary dispensaries per 1000 milching animals
	Veterinary aid centre (stockmen centres/mobile dispensaries) per 1000 milching animals
	Veterinarian to cattle ratio
	Sanctioned mobile veterinary units per 1000 milching animals
	Cattle vaccinated against foot and mouth disease
	Cattle vaccinated against brucellosis
	Number of artificial inseminations performed
Financial allocation and policy support	Number of beneficiaries under the Dairy Entrepreneurship Development Scheme (DEDS) per million human population
	Subsidy amount released under DEDS per average beneficiary
	Financial outlay for agriculture and allied sectors per million human population
	Number of farmers enrolled under the National Programme for Dairy Development (NPDD) per million human population
	Number of cooperative societies in dairy per million human population
	Total membership in dairy cooperative societies per million human population
	Number of projects sanctioned under NPDD per million human population
	Fund utilisation percentage under NPDD
Dairy infrastructure	Dairy plant capacity per 1000 litres of milk produced
	Operational cold storage projects per 1000 milching animals
	Liquid milk marketing per 1000 milching animals
	Bulk milk coolers per million litres of milk production
	Fourier transform infrared technology-based milk analyser/ food scan/ powder analysers per 1000 litres of milk production
	Automatic milk collection units per 1000 litres of milk production
	Data processor and milk collection units per 1000 litres of milk production
	Electronic adulteration testing units per 1000 litres of milk production

Source: Authors

6.4 Results

6.4.1 State ranking

Table 5: State ranking

States	Overall rank	Production and productivity	Access to veterinary healthcare	Financial allocation and policy support	Dairy infrastructure
Punjab	1	1	11	4	12
Haryana	2	2	4	8	11
Gujarat	3	5	8	2	2
Rajasthan	4	3	18	5	16
Goa	5	14	1	17	1
Kerala	6	8	6	11	3
Andhra Pradesh	7	4	3	7	13
Karnataka	8	11	5	3	4
Uttarakhand	9	13	13	1	6
Himachal Pradesh	10	6	9	10	15
Madhya Pradesh	11	7	17	16	18
Telangana	12	12	12	9	10
Tamil Nadu	13	15	7	6	8
Uttar Pradesh	14	9	15	14	19
Maharashtra	15	10	20	13	7
Bihar	16	16	16	12	9
Odisha	17	20	2	15	5
West Bengal	18	17	10	18	17
Chhattisgarh	19	18	14	20	20
Jharkhand	20	19	19	19	14

Source: Authors

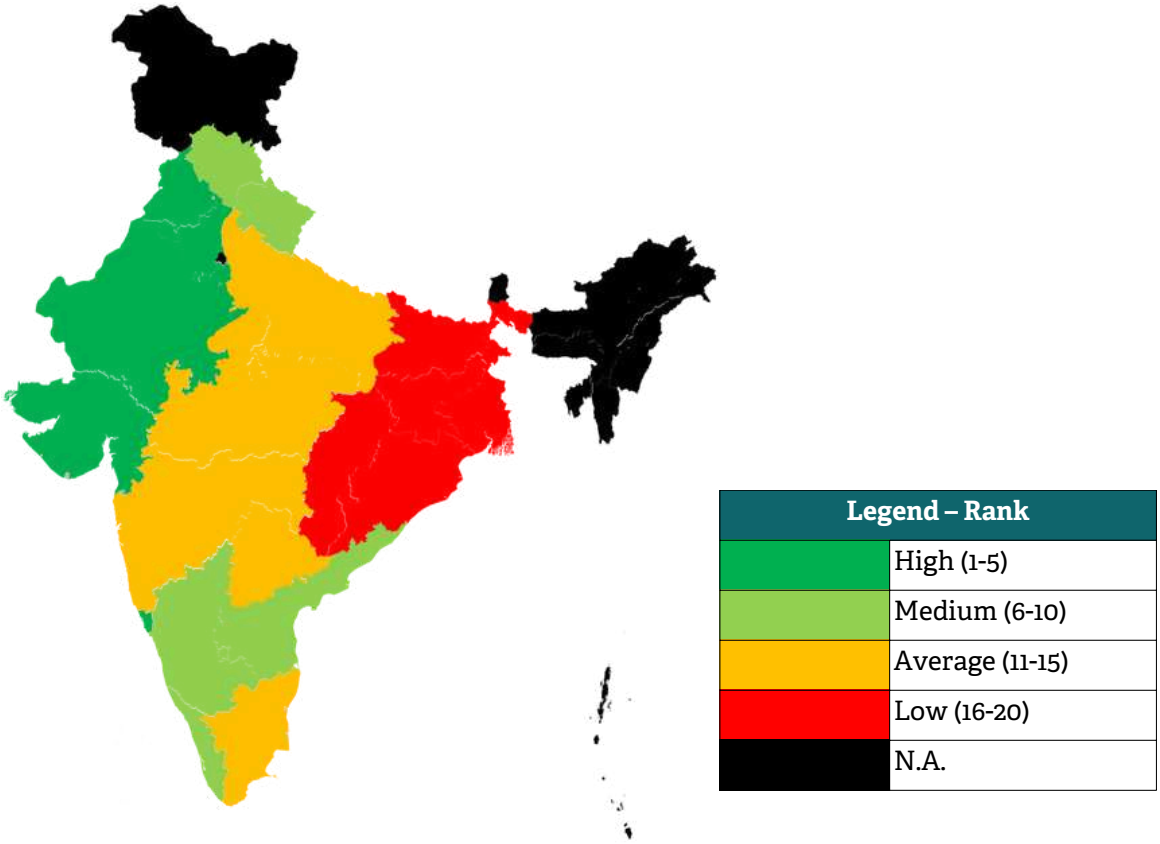
6.5 Analysis and discussion

6.5.1 Overall performance

- Punjab, Haryana, and Gujarat emerge as the top three States in terms of the aggregate score of this index. This is due to an established presence in the dairy sector over the course of many decades. These States score high in terms of the population density of milching animals and the overall milk yield from cows and buffaloes. The States also lead in terms of the per capita availability of milk. All these States have a long-standing tradition of dairy farming, with a strong cultural and historical connection to the practice, and have high-yielding cattle breeds like Gir, Sahiwal and Hariana. (Toppo, 2021)

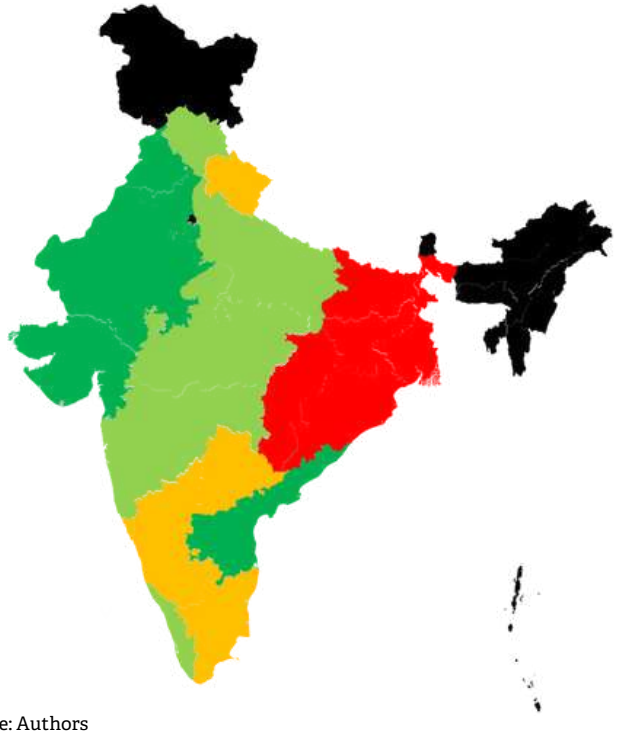
- The western and southern States of Maharashtra, Telangana, and Tamil Nadu show average scores, aligning with their milk production capacities. Despite their significant geographical expanse, these States receive average ratings across the four sub-indices. This suggests a possible disparity in the functioning of the dairy industry within these regions. Goa emerges as an outlier, ranking higher, due to its small population and denser distribution of resources per capita compared to the larger States.
- It's worth noting that in this index, States with extensive land areas and significant livestock populations aren't given preferential treatment in terms of scoring. The parameters are normalised based on factors such as the number of milching animals, human population, or litres of milk production to ensure fair ranking.

Figure 4: Overall performance



Source: Authors

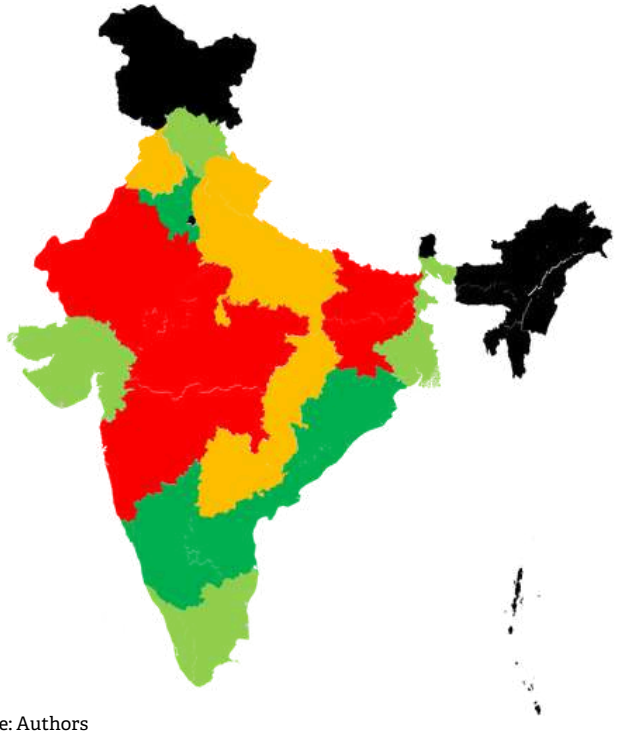
Figure 5: Milk production and productivity



Legend – Rank	
	High (1-5)
	Medium (6-10)
	Average (11-15)
	Low (16-20)
	N.A.

Source: Authors

Figure 6: Access to veterinary healthcare



Legend – Rank	
	High (1-5)
	Medium (6-10)
	Average (11-15)
	Low (16-20)
	N.A.

Source: Authors

Figure 7: Volume of milk production

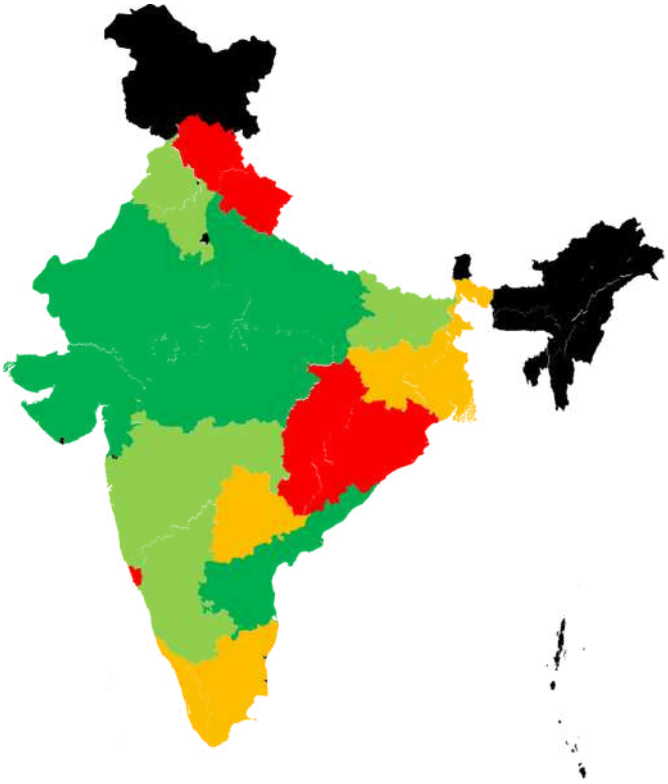


Table 6: State milk production

Rank	State	Milk production in '000 litres
1.	Rajasthan	33264.7
2.	Uttar Pradesh	33005.02
3.	Madhya Pradesh	19004.25
4.	Gujarat	16722.11
5.	Andhra Pradesh	15403.08
6.	Maharashtra	14304.51
7.	Punjab	14076.76
8.	Bihar	12118.5
9.	Karnataka	11795.79
10.	Haryana	11629.52
11.	Tamil Nadu	10107.43
12.	West Bengal	6414.48
13.	Telangana	5807.78
14.	Jharkhand	2629.37
15.	Kerala	2532.46
16.	Odisha	2402.06
17.	Uttarakhand	1856.27
18.	Chhattisgarh	1848.35
19.	Himachal Pradesh	1615.29
20.	Goa	63.21

Legend	High (Rank 1-5)	Medium (Rank 6-10)	Average (Rank 11-15)	Low (Rank 16-20)	N.A.

Source: Basic Animal Husbandry Statistics

6.5.2 Milk production and productivity

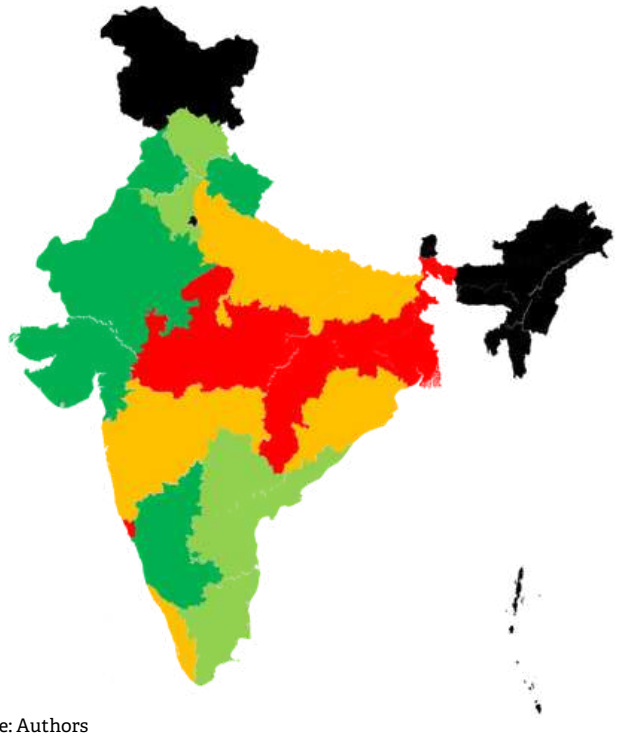
- Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat and Andhra Pradesh lead the country in total milk production, primarily due to the large milching animal population in these regions (Figure 7 and Table 6). The diversity of cattle breeds and favourable agro-climatic conditions also create suitable conditions for these States to generate high volumes of milk production.

- However, the scenario shifts when introducing productivity to the comparison between States. Punjab and Haryana emerge as the leading States, despite their smaller livestock footprint than many larger States. For example, in Punjab, crossbred cows yield an impressive daily average of 13.88 kg—surpassing the indexed States' average by over 1.5 times. Conversely, indigenous cows yield 9.17 kg daily, a remarkable 2.5 times above the indexed States' average. Haryana takes the lead in buffaloes, with a daily milk yield of 10.28 kg—nearly double the indexed States' average.
- In States like Uttar Pradesh, Madhya Pradesh, and Tamil Nadu, we observe a notable disparity between their milk productivity and milk production (Figure 5 versus Figure 7). Ranked 2, 3 and 13 in overall milk production, their positions slip to 9, 7 and 15 respectively, when productivity is factored in. The disparity may stem from limited adoption of high-yielding cattle breeds, suboptimal feeding and healthcare practices, and the challenges of adequately resourcing a vast and diverse cattle population. Unlike Andhra Pradesh, the majority of south Indian States achieve medium to average scores. This outcome may be largely attributed to the prevalence of low milk yield in milching animals.
- Despite being the sixth largest milk-producing State, with an output of over 14.3 million litres annually (Table 6), Maharashtra's rank falls to tenth when considering productivity, mirroring the trend observed in other large States. Notably, Maharashtra has been facing a decline in milk production due to heat stress. A Lancet study found that by 2085, increasing heat stress can cause up to 25 percent decline in milk production in India's arid to semi-arid areas including Maharashtra (Gurjar, 2022).

6.5.3 Access to veterinary healthcare

- India has a limited number of private veterinary services, with no comprehensive database containing the number of individuals, companies and NGOs engaged in this sector. The analysis, therefore, is limited to government-owned veterinary service providers (Vet Helpline India, 2020).
- Several large States, including Gujarat, Maharashtra, and Madhya Pradesh, fall within the medium to low ranks of the access to veterinary healthcare ranking (Figure 6). This pattern may reflect higher demand for veterinary services due to the larger populations of milching animals in these areas. For instance, often, the density of stationary and mobile veterinary centres in these regions is at least three to four times the average of the States listed in this index.
- Most southern Indian States demonstrate moderate access to veterinary healthcare services. This trend may be largely attributed to the lower density of livestock in these regions.
- While both Punjab and Haryana lead in milk productivity, only Haryana maintains this leading position in veterinary healthcare; Punjab lags significantly in mobile veterinary dispensaries per 1,000 milching animals, with a ratio over 68 times lower than the average of the indexed States.

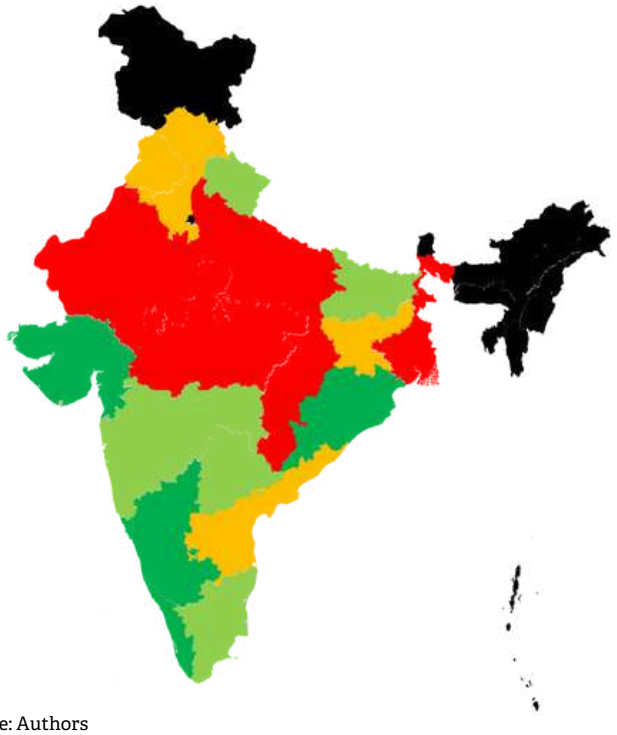
Figure 8: Financial allocation and policy support



Legend – Rank	
	High (1-5)
	Medium (6-10)
	Average (11-15)
	Low (16-20)
	N.A.

Source: Authors

Figure 9: Access to dairy infrastructure



Legend – Rank	
	High (1-5)
	Medium (6-10)
	Average (11-15)
	Low (16-20)
	N.A.

Source: Authors

6.5.4 Financial allocation and policy support

- We observe a correlation between parameters 'financial allocation and financial support' and 'milk productivity' for States like Gujarat, Punjab and Rajasthan that score high in milk productivity. The States house a high number of cooperative societies and memberships in cooperative societies. For instance, in Gujarat, the total membership in the dairy cooperative societies per million human population is almost four times the indexed States' average.
- Most States in eastern India, score low across this component which could be attributed to a lower number of dairy cooperative societies.
- Southern Indian States, such as Tamil Nadu, Telangana, and Andhra Pradesh, have scored above average in fund allocation under the Dairy Entrepreneurship Development Scheme (DEDS), as well as fund utilisation under National Programme for Dairy Development (NPDD). However, a smaller number of dairy farmers are part of the organised dairy cooperatives in these States.
- For Maharashtra, despite the presence of big dairy cooperatives, the State scores low because of the below-average participation of dairy farmers in programmes like NPDD and DEDS.

6.5.5 Dairy infrastructure

- The dairy infrastructure component encompasses the adoption of modern technology in the dairy industry and ongoing projects, especially for cooperative-level dairy farms. Consequently, States with larger livestock populations often face challenges in meeting the higher demand with their limited infrastructure. This pattern is particularly noticeable in central India and certain regions of northern India. For instance, in Uttar Pradesh, the total capacity of dairy plants and the number of operational cold storage projects are up to three times less dense than the indexed States' average.
- Like in the case of veterinary healthcare service distribution, Goa stands as an outlier due to its smaller size, leading to lower demand for such services given its smaller livestock population.

6.5.6 Milk procurement: private sector and cooperatives

Figure 10: Milk procurement: private sector and cooperatives

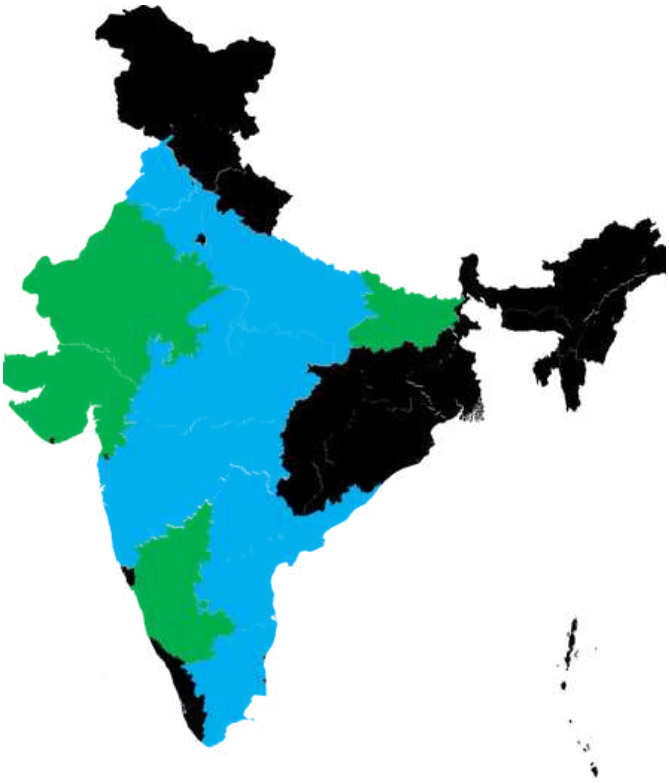


Table 7: Milk procurement distribution

State	Private (*LKPD)	Cooperative (LKPD)
Punjab	30-32	17-19
Rajasthan	27-29	28-30
Gujarat	12-14	225-227
Maharashtra	123-127	36-38
Karnataka	12-14	80-84
Bihar	7-9	18-20
Madhya Pradesh	30-32	9-11
Telangana	12-14	5-7
Andhra Pradesh	35-37	14-16
Tamil Nadu	75-79	36-38
Haryana	27-29	4-6
Uttar Pradesh	121-125	5-7
Other States	33-35	47-49
All India	557-562	535-540

Source: Crisil, (*Lakh KG per day)

In India, milk procurement is closely split between private and cooperative entities. As of 2021, private dairy enterprises accounted for over 60 percent of the country's dairy processing capacity, with a significant contribution from value-added products, driving market growth (ENS Economic Bureau, 2021). Approximately 35 percent of India's dairy market operates in an organised manner, characterised by efficient milk procurement networks and the marketing of liquid milk and value-added products. Notably, the private sector's share of milk handling has surpassed that of the cooperative sector and is expected to continue growing in the future. This shift is driven by both new entrants and existing players expanding their distribution networks in their core regions (Manohar, 2021). However, when we delve into the State-level distribution, a different trend emerges. The majority of States are primarily influenced by the private sector, while only four States—Gujarat, Rajasthan, Bihar, and Karnataka—display a substantial cooperative presence. This divergence in the cooperative-private sector distribution in Gujarat and Karnataka can be directly attributed to the dominance of two key brands – Amul and Nandini, respectively (CRISIL, 2022).

6.6 Emerging States

Beyond the States covered in the Index, the eight northeastern States—Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura—display promising trends. When measured against well-established dairy States, most of these northeastern States excel in veterinary healthcare accessibility and dairy infrastructure. This achievement primarily stems from a lower population of milching animals, resulting in diminished demand for such facilities. Moreover, the region has witnessed heightened government interventions in the dairy sector in the recent past. Nonetheless, due to the recent nature of these advancements, the available data covers a shorter time series, thereby making a direct comparison with larger, more established dairy States inequitable.

6.7 State selection

To conclude, our analysis sheds light on the performance of Indian States across defined parameters related to the dairy sector. By utilising a comprehensive index and employing ratio scales to ensure fair comparisons, we have identified leading States in terms of the overall score, milk production and productivity, access to veterinary healthcare, financial allocation and policy support, and dairy infrastructure. These findings provide valuable insights into the strengths and weaknesses of different States, allowing for targeted interventions and policies to enhance the performance of the local dairy industry. Based on our analysis and the rankings we recommend the four States of Maharashtra, Tamil Nadu, Punjab and Haryana, for conducting detailed field studies across a sample of livestock farmers (small/medium/large) and local veterinarians. These States are often seen as the lighthouses of agro-economic activity in their respective regions, with the ability to influence policy decisions in neighbouring States. Punjab and Haryana hold this role in the North, Maharashtra in the West, and Tamil Nadu in the South. However, the Eastern States lack the framework conditions necessary to inspire scalable interventions beyond their geographies.

Maharashtra: Maharashtra is one of India's leading milk producers with a renowned dairy cooperative movement, called Mahananda. The State is also home to the financial capital, Mumbai, and holds considerable economic sway in the western region.

- **Productivity:** Despite being a dairy-developed State with the highest concentration of indigenous breeds of cattle and buffalo, data from the index highlights significant shortfalls. There are issues in the total milk production and the average productivity levels across the State. For example, in 2021, the average milk yield for indigenous cattle in the State was 2.34 kg per day. This is over 33 percent less than the indexed States' average of 3.5 kg per day (Ministry of Fisheries, Animal Husbandry and Dairying, 2022). This lower milk productivity likely stems from the overwhelming majority of local breeds within the State (Gamit, 2021).
- **Distribution of milk production:** There is an uneven distribution of milk produced by established dairy producers like Mahananda Dairy, Chitale dairy farms, and Gokul. Additionally, there is a disparity with dairy cooperatives associated with small and medium-sized farmers. For instance, in 2018-19, the total milk procured by smaller dairy cooperatives in Maharashtra stood at only eight percent of the total production. (NDDB, 2020).
- **Dry fodder and clean water shortage:** The State suffers from a critical shortage of dry fodder and clean water. This contributes to low levels of milk productivity, especially in herds owned by small and medium-sized farmers. In 2019, the demand for dry fodder stood at 30.6 million tonnes, nearly 25 percent over the available supply (Roy, Agrawal, Bhardwaj, & Mi, 2019).

- **AI infrastructure and trained veterinarians:** Several gaps exist within the AI support infrastructure and veterinary training. These include inadequate knowledge of diseases, prevention and control which directly impacts animal health, productivity and overall milk production. The veterinarian-to-cattle ratio for the State stands at over 344 vets per million cattle. This is significantly lower than the indexed States' average of almost 9808 vets per million cattle. The State is also under-equipped with the density of veterinary dispensaries, with only 191 units per 1,000 milching animals, compared to the indexed States' average of 382.4 (Singh, 2022).

Tamil Nadu: Although historically not a leading milk producer, Tamil Nadu holds an influential position in southern India. However, its cooperative, Aavin, faces stiff competition from Gujarat's dominant player, Amul, which enjoys a wide presence in India's northern dairy market. The State could benefit from the targeted interventions in key areas identified in this index.

- **Feed sustainability**: The State faces challenges in feed sustainability on account of the year-round unavailability of green fodder, high cost of cattle feed, mineral mixtures and lack of community grazing lands (Gamit, 2021). In 2019, green fodder availability in the State stands at 17735.4 against a demand of 27699.8, representing a deficit of almost 36 percent (Roy, Agrawal, Bhardwaj, & Mi, 2019).
- **Fodder yield:** There is a limited availability of high yielding fodder varieties and seeds. This situation is further compounded by the poor quality of dry fodder, and changing cropping patterns in favour of cash crops. This limits the increase in area under fodder crop production (Radhakrishnan, 2022).
- **Susceptibility to diseases:** The State's cross-bred animals are highly susceptible to disease. This vulnerability largely emanates from the knowledge gaps in disease prevention and exorbitantly priced medicine. This condition is further exacerbated by the State's low veterinarian-to-cattle ratio of over 290 veterinarians per million cattle. This is over 33 times lower than the indexed States' average of almost 9807 veterinarians per million cattle.

Punjab: Punjab is the top-ranking State in this Index, and serves as a benchmark for other northern States in adopting best practices in milk production and productivity. However, gaps in veterinary care and dairy infrastructure still exist, especially when considering the proportion of milk production.

- **Feeding practices:** Farmers in the State face several livestock nutrition-related challenges. These include knowledge gaps and information asymmetries in balanced feeding practices, as well as the high costs of feed.
- **Mortality rates:** Farmers report high mortality rates in male calves and incidences of reproductive disorders which are further compounded by the lack of veterinary care services across the State. The State has a significant shortfall in the number of veterinary aid centres, almost 58 times lower than the indexed States' average (DAHD, 2023).
- Challenges in replacing ageing cows**:** Farmers find it difficult to replace old/disabled cows that are unable to breed and undergo lactation.
- **Price realisation for cow milk:** Due to the high number of buffaloes, farmers face challenges related to price realisation in the case of milk produced from crossbred cows on account of its low-fat content.

Haryana: Although Haryana performs better than Punjab in terms of the veterinarian-to-cattle ratio and the overall healthcare index, a few challenges persist, related to the veterinary care and feed quality.

- **Feed quality:** Challenges in the dependability, quality, and cost of feed inputs, such as concentrate mixtures, disrupt farm-level economics and lead to reduced financial gains.
- **Veterinary services:** The adoption of healthcare practices is limited by insufficient veterinary services and a shortage of adequately trained technicians. The State also lacks adequate mobile veterinary services, with only about 200 MVUs available. This is significantly below the national average of 36.3 units per 1,000 milching animals (Ministry of Fisheries, Animal Husbandry and Dairying, 2023).

07

Survey Results and Discussion

To triangulate our findings from secondary literature, we surveyed farmers and veterinarians in selected States. These include Maharashtra, Tamil Nadu, Punjab, and Haryana for farmers; and Maharashtra, Tamil Nadu, and Punjab for veterinarians.

The survey uses a mixed-methods approach, combining quantitative and qualitative data collection, including face-to-face interviews with 100 veterinarians and 150 farmers. We have categorised farmers by farm size: small – constituting 1-5 cattle, medium – constituting 5-10 cattle, and large – constituting over 10 cattle. This is followed by in-depth qualitative interviews, focused on the most critical issues affecting cattle farming. **This study is not representational.**

Table 8: Sample - farmers

Farmers	**Quantitative**	**Punjab**			**Tamil Nadu**			**Maharashtra**			**Haryana**		
	Districts	Moga	Ludhiana	Jalandhar	Salem	Erode	Coimbatore	Kolhapur	Sangli	Nagpur	Rohtak	Bhiwani	Jind
	Sample Size n=157	16	13	11	12	15	12	18	13	11	14	11	11
	Qualitative	**Punjab**			**Tamil Nadu**			**Maharashtra**			**Haryana**		
	Districts	Moga	Ludhiana	Jalandhar	Salem	Erode	Coimbatore	Kolhapur	Sangli	Nagpur	Rohtak	Bhiwani	Jind
	Sample Size n=50	5	5	3	5	5	3	5	5	3	5	5	2

Table 9: Sample - veterinarians

Veterinarians	**Quantitative**	**Punjab**			**Tamil Nadu**			**Maharashtra**		
	Districts	Moga	Ludhiana	Jalandhar	Salem	Erode	Coimbatore	Kolhapur	Sangli	Nagpur
	Sample Size n=100	12	12	10	12	11	10	12	11	10
	Qualitative	**Punjab**			**Tamil Nadu**			**Maharashtra**		
	Districts	Moga	Ludhiana	Jalandhar	Salem	Erode	Coimbatore	Kolhapur	Sangli	Nagpur
	Sample Size n=30	5	3	2	5	3	2	5	3	2

7.1 Farmers: overview of findings

7.1.1 Haryana

Table 10: Survey results – Haryana

S.No.	Trends	Details
1.	Awareness and adoption of ration balancing and silage	• Prevalent reliance on traditional feeding methods among farmers, and limited awareness about modern feeding practices such as ration balancing and silage utilisation.
2.	Ration balancing vs TMR recognition	• Wider recognition of TMR as a feeding practice over ration balancing. • Consistent awareness and adoption of TMR across farms, regardless of size or livestock capacity.
3.	LCF and silage	• High awareness, knowledge and adoption rate of LCF. • Limited awareness and trust regarding use of silage.

4.	Feed procurement strategies	• Small farmers primarily rely on local markets for feed procurement, often sourcing from neighbouring villages.
		• Medium farmers predominantly use local markets, but show a gradual shift towards livestock input shops and service providers.
		• Large farmers adopt a more selective approach, preferring to source feed from private companies over traditional markets, due to factors including:
		  ◦ Higher quality and reliability of inputs from organised markets.
		  ◦ Cost-effectiveness from bulk purchasing and economies of scale.
		  ◦ Access to finance and credit available in organised markets.

5.	Feed production practices	• Small farmers primarily use crop residues for feed but are increasingly open to incorporating compounded feed into their practices. • Medium farmers maintain a balanced approach, combining crop residues with a growing interest in compounded feed production. • Large farmers are gradually diversifying their feed options, which may reduce their reliance on crop residues.
6.	Discounts in dairy cooperatives	There is a significant gap in the discount utilisation within dairy cooperatives, largely due to: • Low awareness and education levels among farmers and cooperatives about available discounts and incentives. • Limited training and capacity development on the optimal usage of discounts. • Bureaucratic hurdles and inefficiencies that restrict the implementation of existing government schemes. • Outdated technical systems within cooperatives that complicate tracking and applying for discounts.
7.	Fodder seed procurement Strategies	Small farmers rely on community-oriented methods for procuring fodder seeds, whereas larger farmers prioritise commercial sources.
8.	Fodder shortages and feed plans for lactation stages	Farmers maintain stable feed plans for each stage of lactation, incorporating additives like oils (mustard oil or ghee) for smoother calving. They also add calcium to the feed for improved milk quality and supplements like jaggery, for post calving.

7.1.2 Punjab

Table 11: Survey results – Punjab

S.No.	Trends	Details
1.	Location and preferences for fodder cultivation	• Shared preference for personal agricultural spaces for fodder plantation, with limited instances of collaborative land use. • Diverse preferences in fodder plant types, indicating a balanced approach to feed cultivation.
2.	Feed plans for each stage of lactation	• Diverse approaches to manage feed during pregnancy, which include targeted nutrient boosts, specific dietary adjustments, and phased dietary changes post-vaccination. • Vaccination events in the State are linked to dietary modifications implemented by farmers, suggesting a thoughtful consideration of health interventions. • While some farmers maintain consistent diets for stability, others make incremental adjustments based on evolving nutritional requirements.
3.	Awareness and adoption of ration balancing and silage	• Awareness of ration balancing varies significantly across different farm sizes. Overall, medium-sized farmers exhibit the highest levels of awareness at thirty-three percent, with adoption rates at 80 percent. • Large farmers, despite their high levels of adoption, show minimal understanding of the technicalities related to ration balancing. • Overall awareness of TMR is low, although medium-sized farmers have a moderately high adoption rate of 67 percent. • Formulas, adoption and awareness vary for LCF. For instance, medium-sized farmers lead in adoption, with seventy-five percent using these practices. • Small and medium farmers show low awareness and no adoption of LCF, while large farmers have a seventeen percent awareness rate but no demonstrable adoption.
4.	Feed procurement strategies	• Small farmers rely heavily on local markets with limited engagement across alternative sources. • Medium farmers continue to rely on local markets whilst engaging with neighbouring villages. These are considered important due to their role as alternative sources for feed procurement. • Large farmers consistently depend on local markets with minimal engagement and reliance on alternative sources of procurement.
5.	Feed production practices	• Small farmers predominantly use crop residues, hay leaves, and green fodder, showing minimal interest in commercial feeds. • Medium farmers maintain a balanced approach with continued reliance on crop residues while showing emerging interest in compounded feed. • Large farmers are gradually shifting towards more diverse feed options, potentially reducing their reliance on crop residues.
6.	Fodder seed procurement	• Increasing preference for cooperatives for fodder seed procurement, especially by medium-sized farmers.

7.1.3 Maharashtra

Table 12: Survey results – Maharashtra

S.No.	Trends	Details
1.	Feed plans for each stage of lactation	• Wide consensus on maintaining dietary consistency, with an increase in feed quantity as delivery approaches. • Farmers implement systematic modulation in feed quantity throughout conception, gestation, and lactation phases. • Postpartum, there is a deliberate increase in calcium and supplementary nutrients to optimise milk production. • Farmers prefer tailored feeding practices based on different stages of pregnancy for optimal livestock management.
2.	Awareness and adoption of ration balancing and silage	• Farmers in Maharashtra demonstrate higher awareness of ration balancing compared to other regions covered in the survey. • Among small farmers, the rates of awareness and rates of adoption are high, at 82 percent and 65 percent, respectively. • Medium-size farmers show lower awareness at sixty-five percent and adoption at fifty-five percent. • Large farmers exhibit minimal awareness but are strongly inclined towards adopting ration balancing approaches, when given an option. • Awareness and adoption of TMR and LCF vary across farm sizes. Silage awareness levels also differ, with adoption rates at twenty-nine percent among small farmers, twenty-two percent among medium farmers, and no adoption among large farmers.
3.	Feed procurement strategies	• Small farmers predominantly rely on local markets with minimal engagement with alternative sources for feed procurement. • Medium farmers mainly rely on local markets while increasing engagement with livestock input shops and cooperatives for sourcing feed. • Large farmers prefer local markets but are increasingly relying on livestock input shops for their feed procurement needs.
4.	Feed production practices	• Small farmers employ a balanced use of crop residues, hay leaves, and green fodder for feed production. • Medium farmers rely on on-farm resources while showing openness to incorporating compounded feed into their practices. • Large farmers are slightly decreasing their utilisation of on-farm resources and exploring the potential use of commercial feeds for their livestock.
5.	Discounts in dairy cooperatives and fodder seed procurement	• Engagement in dairy cooperatives does not rely heavily on discounts, indicating a nuanced landscape of cooperative participation. • Fodder seed procurement in the State does not exhibit reliance on any particular source, reflecting a diverse approach to sourcing seeds for fodder production.
6.	Place of plantation and fodder plant preferences	• Overwhelming reliance on own agricultural land for fodder production, highlighting the prevalent use of personal resources for feed cultivation. • High preference for perennial plants in fodder production, with similar preferences for leguminous or non-leguminous varieties.
7.	Fodder shortages in Maharashtra	• Around 71.4 percent of respondents reported fodder shortages, indicating persisting challenges in ensuring adequate feed availability for livestock in the region.

7.1.4 Tamil Nadu

Table 13: Survey results – Tamil Nadu

S.No.	Trends	Details
1.	Feed plans for each stage of lactation	• Farmers adjust feed plans during lactation to meet specific nutritional needs. For instance, they add lentils to the diet to boost nutrition and meet the higher energy demands of lactating animals.
2.	Awareness and adoption of ration balancing and silage	• Awareness of ration balancing is modest, with varying adoption rates across different farm sizes. • Despite high awareness of TMR, adoption remains limited among almost all farmer categories - small, medium and large. • The LCF formula is well-known, but adoption rates are inconsistent. • While silage awareness is high across all farm sizes, adoption rates are negligible, with small farmers at 13 percent and medium to large farmers not adopting it at all.
3.	Feed procurement strategies	• Small farmers primarily rely on local markets for feed procurement, but also engage significantly with private companies and neighbouring villages. • Medium farmers continue to use local markets while increasingly sourcing feed from livestock input shops and private companies. • Large farmers prefer local markets but also procure feed from livestock input shops, private companies, and neighbouring villages.
4.	Feed production practices	• Small farmers primarily rely on leftovers from home-cooked food, facing challenges with other feed types. • Medium farmers are moving away from using on-farm residues and are turning to purchased or market-driven feeds. • Large farmers adopt a diversified approach, emphasising leftovers, hay leaves, and compounded feed in their practices.
5.	Discounts in dairy cooperatives and fodder seed procurement	• The State exhibits limited use of discounts in dairy cooperatives, suggesting broader structural or operational challenges within the system • Large farmers prioritise commercial sources for fodder seed procurement, while cooperatives play a significant role in facilitating seed access.
6.	Place of plantation and fodder plant preferences	• Farmers use both their own and agricultural land for fodder plantation, with limited use of idle or shared land. • Farmers prefer seasonal and perennial plants for fodder and do not have a strong preference between leguminous and non-leguminous varieties.
7.	Fodder shortages	• No reports of fodder shortages, suggesting effective management practices and ample availability of feed resources for livestock in the region.

7.2 Veterinarian study

7.2.1 Existing feed quality

Table 14: Veterinarian survey: feed quality

State	Details
Maharashtra	• About 25 percent of animals lack adequate nutrition, with farmers expressing concerns about the absence of essential supplements like calcium and minerals. • Farm size influences feed choices, with larger farms prioritising quality and smaller farms prioritising affordability. Private companies are responding to this need by manufacturing improved feeds with higher protein content. • Veterinarians attribute good cattle management to factors such as regular payments from milk buyers. For example, a leading dairy cooperative, Gokul, provides high-quality feeds to their members.
Punjab	• Large herd owners focus on cultivating their own feed, hinting towards financial prosperity and higher awareness of feed quality. • During green fodder price hikes, farmers often compromise on the quality of market-sourced feed, affecting essential components like mineral mixtures. • Economic factors drive farmers to choose more affordable alternatives, which impacts the overall nutritional balance of the feed. • Government support for straws and fodder in Punjab is inconsistent, and is mainly provided during scarcity periods to assist farmers.
Tamil Nadu	• Main types of feed in the State are wet grass, dry feed sourced from vendors such as Hatsun and Aavin, and a combination of green fodder and concentrate. • Integrated feed options often include mixtures like Cumbu Napier Hybrid with oil cakes such as groundnut and cotton seed cake. • Feed quality directly influences milk production, with larger herds finding it economically viable to invest in higher-quality feed. • Recommended feeding methods include using feed additives and supplements, allowing natural grazing, and practising stall feeding to ensure optimal nutrition for livestock.

7.2.2 Feeding practices

Table 15: Veterinarian survey: feeding practices

S.No.	Trends	Details
1.	Type of feeding suggested for milk producing bovine	• Veterinarians recommend feed additives and supplements across all States. • Farmers in Maharashtra more commonly practise natural grazing, while stall feeding is prominent in Tamil Nadu for milk-producing bovines. • Government and private institutions use similar methods when recommending feed types for dairy animals. • Farmers in Maharashtra prioritise larger herds for better feed quality, Punjab focuses on cultivating their own feed, and Tamil Nadu emphasises selecting feed types that optimise milk production. • Common challenges across States include inconsistent government support and compromises in feed quality. Despite these issues, veterinarians widely recommend feed additives and supplements, especially in Punjab, where 89 percent respondents endorse them.
2.	Feed plan practices	• Overall, 77 percent farmers seek feed-related advice, led by Punjab with 97 percent demand, followed by Tamil Nadu with 67 percent and Maharashtra with 64 percent. • Government institutions are more proactive in offering recommendations compared to private entities.
3.	Type of feed recommended	• Crop residues, farming residues, and surplus farm production receive widespread support across all States, with endorsement rates of 94 percent in Maharashtra, 100 percent in Punjab, and 85 percent in Tamil Nadu. • Regional differences exist in the recommendation of hay leaves, with 32 percent endorsement in Maharashtra, three percent in Punjab, and 97 percent in Tamil Nadu. • Veterinarians highly endorse grasses including green fodder and napier grass, constituting 87 percent in Maharashtra, 89 percent in Punjab, and 94 percent in Tamil Nadu. • Compounded feed or feed concentrate has lower approval, with 26 percent endorsement in Maharashtra and 100 percent in Tamil Nadu, largely influenced by economic feasibility. • Around 52 percent respondents endorse alternate crops or locally available substitutes in Maharashtra, followed by Tamil Nadu with 85 percent, but none of the respondents in Punjab support these options.
4.	Feed plan practices (awareness and adherence)	• Around 79 percent of farmers are aware about ration balancing, while 63 percent follow the practice. Punjab has the highest awareness but the lowest adoption rates. • Around 81 percent of farmers are aware about TMR, while sixty-two percent adhere to recommended practices. Respondents in Punjab have high awareness but low adoption rates. • Overall, 80 percent of farmers are aware about, and sixty-seven percent adopt LCF, with Maharashtra showing the highest awareness but relatively lower adoption rates. • Around 82 percent of farmers are aware about silage production, and 61 percent adopt the practice. However, respondents in Punjab exhibit both low awareness and adoption. • Government institutions lag behind private institutions in both awareness and adoption of modern feed plan practices.

7.2.3 Volume and price of feed rations recommended

Table 16: Veterinarian survey: feed volume and price

S.No.	Trends	Details
1.	Hay leaves: volume and price	• In Maharashtra, veterinarians recommend varying quantities of hay leaves: 30 percent suggest 201 to 300 kgs, and 20 percent each recommend 301 to 400 kilograms and 601 kilograms or more. • In Punjab, veterinarians recommend 100 kilograms or less per herd. • Tamil Nadu shows a diverse pattern, with 69 percent recommending 100 kilograms or less and 31 percent recommending 101 to 200 kilograms. • Government institutions advocate for quantities below 100 kilograms for 71 percent of their respondents, while 45 percent of private institution respondents agree with this recommendation. • Around 70 percent of respondents in Maharashtra recommend prices between ₹10 and ₹20 per kilogram for the average prices of hay leaves. In Punjab, respondents prefer prices of ₹31 or more per kilogram. In Tamil Nadu, 50 percent suggest prices of ₹10 or less, and 44 percent recommend ₹11 to ₹20 per kilogram. • Overall, a weak positive correlation exists between the price and the volume of hay leaves recommended.
2.	Green fodder/napier grass/grasses: volume & price	• Recommendations for Maharashtra vary, Punjab uniformly recommends 201-300 kg, Tamil Nadu recommends less than 200 kg per herd. • In government institutes, 51 percent respondents recommend volumes of 10-200 kg, while in private institutes, 75 percent respondents recommend volumes in the range of 101-300 kg per herd. • In Maharashtra, 92 percent respondents recommend a rate below ₹30 per kg, while for Punjab, 88 percent respondents recommend rates between ₹21-30. In Tamil Nadu, 87 percent respondents recommend rates between ₹21-₹30. • There is a very weak positive correlation between price and volume for green fodder overall.

7.2.4 Nutrition for calves in bovine farming

Table 17: Veterinarian survey: nutrition for calves

S.No.	Trends	Details
1.	Type of milk feeding methods	The suckling method is the most preferred for feeding calves, with 82 percent of respondents choosing this approach. In Maharashtra, 58 percent of respondents also prefer bucket milk feeding. The Maharashtra Government prescribes bucket milk feeding more frequently, with 24 percent of its recommendations, while private institutions recommend it only 11 percent of the time.
2.	Feeding systems	Veterinarians give unified feeding guidelines to calves across different States and groups, showing a common approach in recommendations.
3.	Age of feeding	According to 59 percent of respondents, the most common recommendation is to feed milk to newborn calves until they reach six months of age.However, in Maharashtra, 79 percent of respondents reported feeding milk to calves before they reach five months of age.
4.	Milk replacer and calf rations	Awareness about feeding milk replacers and calf rations is widespread across States, although Maharashtra has slightly lower awareness at eighty-eight percent. Government institutions generally demonstrate higher awareness levels compared to private institutions.

08

Recommendations

Based on the findings from the survey and secondary literature, we recommend implementing the following measures:

- Government Support for farmer training: The government could develop comprehensive training programmes for farmers to improve their awareness and technical understanding of modern feeding practices. These include ration balancing, TMR, and silage utilisation.
- Enhanced access to high-quality feed: Farmers need better access to high-quality feed. This is where organised markets play a critical role, as they can provide better access to bulk purchasing and finance options. This makes high-quality feed more affordable, especially for small and medium-sized farmers.
- Modernisation of dairy cooperatives: Dairy cooperatives need to modernise and streamline their operating systems to improve the utilisation of discounts for farmers. This can include training farmers and cooperative staff on the design and implementation of schemes, and making them more accessible to farmers.
- Promotion of diverse fodder plants: The government needs to encourage the cultivation of perennial and diverse fodder plants to ensure sustainable fodder production on personal agricultural land. This could help maintain a consistent and reliable supply of high-quality fodder, essential for sustaining livestock health and productivity.
- Increasing the number of veterinary professionals: States need an increased number of veterinary professionals by establishing more veterinary colleges and diploma programmes. This could ensure farmers have better access to skilled veterinary services, reducing misdiagnoses and improper treatments.
- Strengthening veterinary care in remote areas: States need to strengthen the deployment and equipment of MVUs to provide timely and adequate veterinary care in remote areas. This could improve animal health and reduce economic losses as a result of downtime.
- Training of AI technicians: Veterinary institutions need to improve the training and regulation of AI technicians to increase the AI coverage. This is much needed to improve herd performance and reduce economic losses from reproductive issues.

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