5. Livestock: Raising Cattle and Buffaloes

5.1 Definition of the Livestock Sector

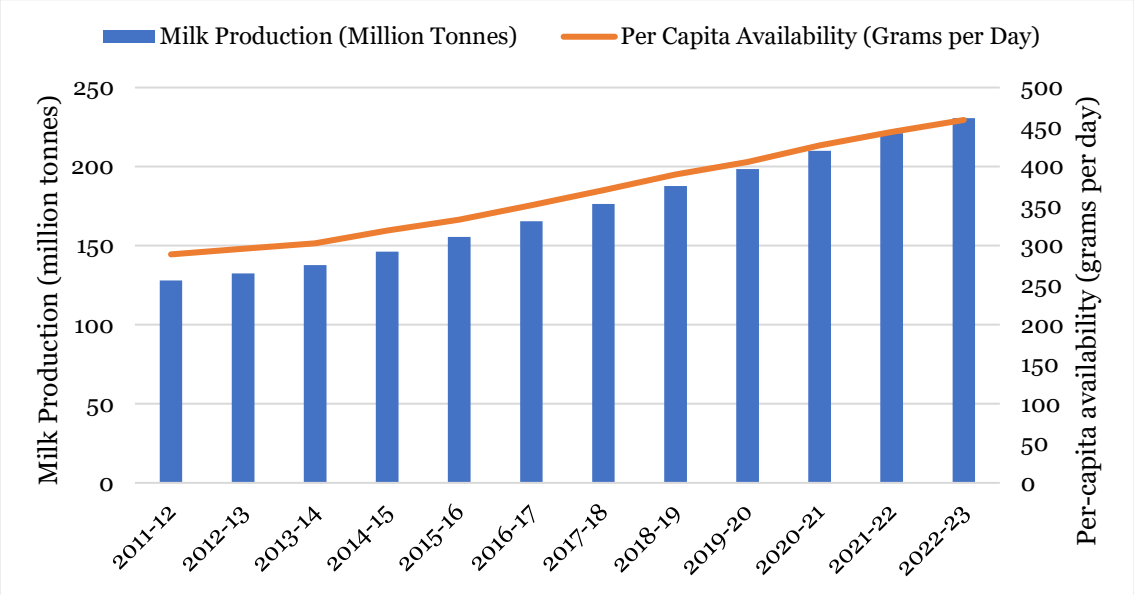
The livestock sub-sector that is used in this report for analysis is the NIC code, 0141 which includes 'raising of cattle and buffaloes'. Box 5.1 gives a small snapshot of the dynamics of this sub-sector. This sub-sector includes the following NIC codes at the 5-digit level:

- Raising and breeding of cattle and buffaloes (01411): Industries whose main activity is the raising of cattle fall under this category (including animals for dairy herd replacements). It includes things like breeding buffalo as well as cattle. The care, feeding, and genetic selection of these animals—as well as their production—are the main topics of discussion.
- Production of milk from cows or buffaloes (01412): Industries that produce milk largely from dairy cows and buffaloes fall under this category. It includes all operations pertaining to the production, delivery, and processing of milk.
- Production of bovine semen (01413): Industries that produce bovine (cattle) semen primarily for artificial insemination fall under this category. Bovine frozen semen is an essential resource for enhancing genetic diversity among bovine herds through the spread of better germplasm. Minimal requirements are followed during the production procedure to guarantee high-quality semen for AI applications.
- Support activities for animal production (01620): This class includes agricultural activities on a fee or contract basis such as activities to promote propagation, growth and output of animals, herd testing services, droving services, agistment services, poultry caponising, coop cleaning, etc. activities related to artificial insemination, stud services, sheep shearing, farm animal boarding and care, activities of farriers.

Box 5.1: Snapshot of the livestock sector

According to the FAOSTAT production data, India ranked as the world's greatest producer of milk in 2021–2022, contributing 24.6 per cent of the world's milk production. Available data indicate that milk production has been over 230 million tons in 2022–23 (Figure 1) and expanding at about 5.3 per cent annually at a compounding rate since 2013-14, matching growth in demand as higher incomes spur more consumption of fluid milk and dairy products, which is nutritionally important component of average diets with per capita availability of 459 grams per day. Despite being the world's largest producer of milk, India accounts for only 1.5 per cent of the world's total milk exports.

Figure 5.1: Milk production (in million tons) and per capita availability (grams per day) in India, 2011-12 to 2022–23



Source: Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying. 2023. Basic Animal Husbandry Statistics-2023. https://dahd.nic.in/sites/default/filess/BAHS2023.pdf. Krishi Bhawan, New Delhi.

One of the prime reasons is the low yield of Indian cows. The milk yield of Indian cows is only about two-thirds of the global average, and it is significantly lower than that of cows in developed nations, according to the FAO. The USA tops the list with a milk yield of about 10,189 litres per lactation while India with only 1, 318 litres per lactation is nowhere near it. As per Integrated Sample Survey average annual productivity of cattle in India during 2019–20 was 1,777 kg per animal per year as against the world average of 2,699 kg per animal per year during 2019 (as per FAO Statistics). Annexure 5.1 shows the state-wise productivity indicators. The sector is largely informal with cooperatives formed in a few regions shows how fragmented this sector is leading to the production of poor-quality milk. The concerned authorities need to address the lack of infrastructure, logistics and subsequent bottlenecks in the supply chain using technological support. One major barrier is the lack of knowledge and instruction among farmers regarding the benefits of modern dairy farming techniques. The key to overcoming this challenge is to provide training and knowledge dissemination to encourage innovation in milking techniques. The Government has taken up various schemes and implemented them to upgrade the dairy practices of India.

Sources:

Ministry of Fisheries, Animal Husbandry and Dairying. 2021. "Productivity of Dairy Animals". *https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1707187#:~:text=As%20per%20Integrated%20Sample%20Survey%20average%20annual%20productivity,per%20year%20during%202019%20%28as%20per%20FAO%20Statistics%29*. March 2.

Ministry of Fisheries, Animal Husbandry and Dairying. 2023. "India ranks first in milk production in the world contributing 24 per cent of global milk production". *PIB. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1897084*. February 7.

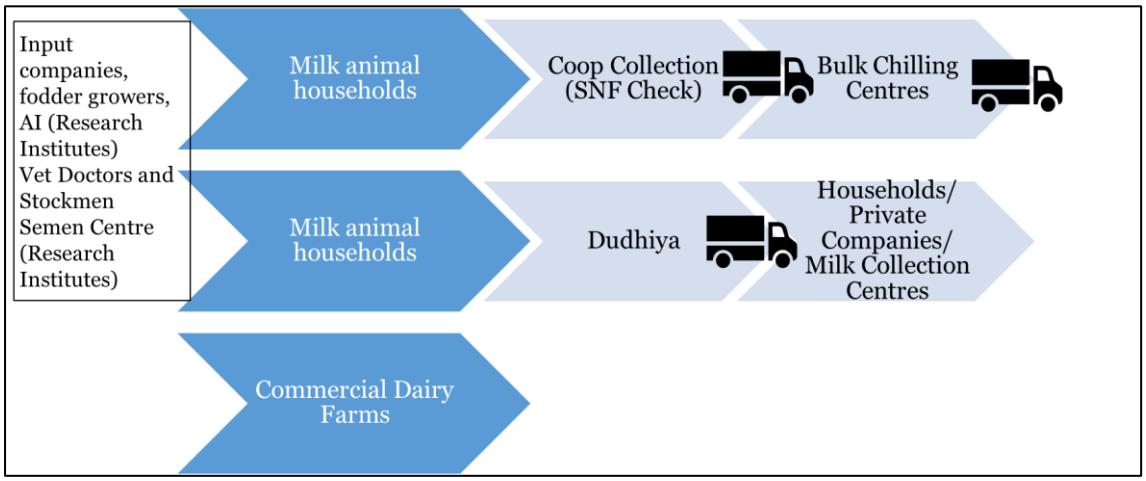
5.2 Value Chain

The dairy value chain encompasses the entire journey from production to consumption, ensuring that dairy products reach consumers in optimal condition. For dairy products to reach customers in the best possible condition, the entire manufacturing and consumption process is included in the value chain (Figure 5.2). There are two core starting points for milk production, first is milk animal households and the other is Commercial Dairy Farms.

The process starts with input chains, covering broadly the collection and distribution of animal feed and fodder. Animal health and breeding are captured through veterinary services, artificial insemination, and bovine semen. The milk production part starts with milk animal households, which have two broad categories of value chain mechanisms. The first is through the Cooperative Collection Centre and the second is through '*Dudhiyas*'. The major mechanism is explained below:

1. From milk animal households, the milk is collected by:
   i) Cooperatives formed by the dairy farmers who send it to their Bulk Chilling Centres. This collected milk is pasteurised, homogenised, and only after conducting quality control checks, is then further distributed through wholesalers and retailers. They are generally found at the State and sub-national level.
   ii) The *Dudhiya* community generally collects milk from dairy farmers in clean and germ-free containers. From there on, they either sell the collected milk to households or Private Companies or bring their milk to Collection Centres where it undergoes quality tests and then processed.
2. Commercial Dairy Farms, in most cases, breed their cattle and buffaloes. They invest in them, from feed and fodder to veterinarians as well as maintain a Research and Development wing to ensure quality milk is produced. They directly take the milk to the Bulk Chilling Centres, where the milk is further processed and then distributed through their supply chain.

Figure 5.2: Value chain in the livestock sector



Source: NCAER conceptualisation from literature review.

Sector and digital technological advancements collectively contribute to higher yields, better animal health, and improved dairy sector profitability, ultimately

strengthening rural livelihoods and sustainable dairy farming practices. There are four ways in which technology is transforming the dairy sector:[1]

1. *Precision Feeding*
    a. Precise amounts of feed provided to cows ensure optimal balance of nutrients.
    b. This decreases feed wastage as well as increases milk productivity.
    c. Sector-specific innovations, like artificial insemination, improved breeding efficiency and genetic quality, leading to superior livestock with enhanced milk production and disease resistance.
2. *Automated Milking Systems*
    a. By decreasing labour costs, it is possible to increase efficiency.
    b. Optimises milking schedules and ensures consistency and precision.
    c. By recording and monitoring cow's milk yield, we can identify the anomalies on time.
3. *Data-driven decision making*
    a. Aid in gaining invaluable insights into herd's well-being and productivity.
    b. Data-driven decisions can be made on breeding, nutrition, and health of cows.
    c. Health monitoring systems can be used to track vital signs and behaviour.
    d. Can detect illness thereby enabling timely intervention, and reducing the need for antibiotics.
    e. Further, digital technologies, such as artificial intelligence, enhance herd management, disease detection, and automated feeding systems, enabling farmers to monitor livestock health in real-time and optimize nutrition for higher milk yields.
    f. The integration of blockchain technology is also emerging, ensuring greater transparency in milk procurement, fair pricing, and traceability from farm to consumer.
4. *Environmental Monitoring*
    a. Environmental monitoring system tracks and manages water usage, waste management and energy efficiency.
    b. By monitoring resource consumption, we can identify sustainable areas to invest in.
    c. Improved refrigeration technologies ensure better milk preservation, reducing spoilage and enhancing supply chain efficiency, which is particularly crucial for dairy farmers in remote areas.

[1] TT Consultants. 2023. "Digital Innovation in Dairy: Sustainable Tech Solutions. TT CONSULTANTS". https://ttconsultants.com/the-moo-vement-towards-tech-companies-shaping-the-digital-dairy-landscape/. September 27

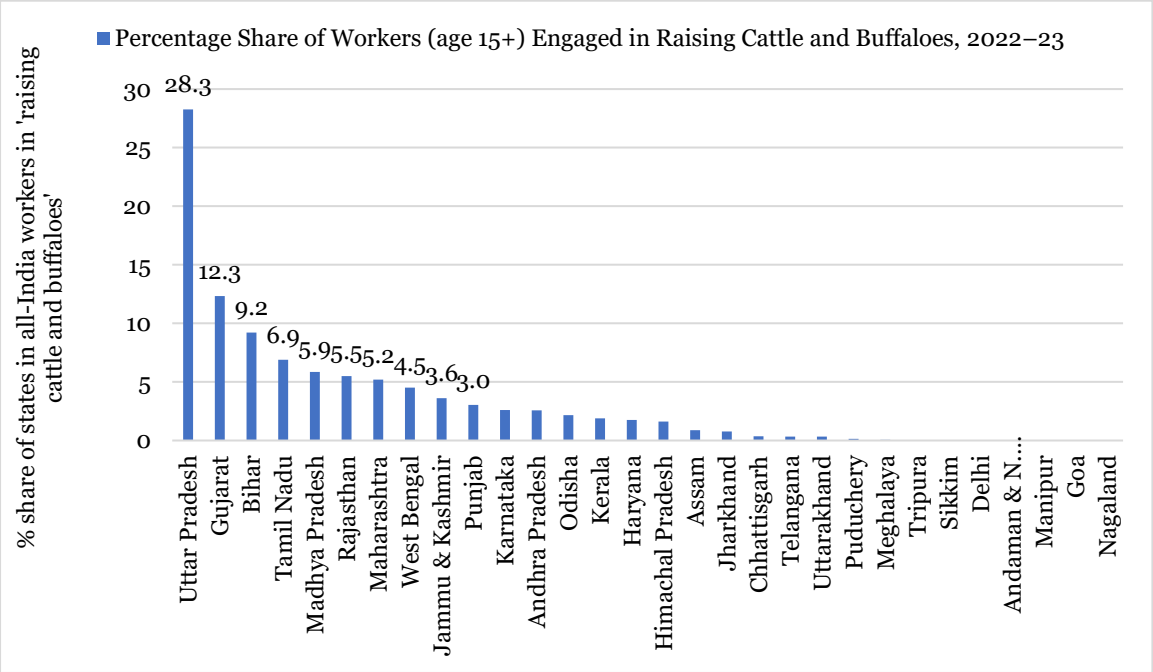
2. Dennis, M. 2023. "The 3 tech trends taking the dairy farming industry by storm". *Food Infotech*. https://www.foodinfotech.com/the-3-tech-trends-taking-the-dairy-farming-industry-by-storm/. September 11.

5.3 Workforce Characteristics

a. **Female Workers**: 82 per cent of the workers in this sector are women.
b. **State-wise distribution**: 78 per cent of the workers in this sector belong to 8 States namely Uttar Pradesh, Gujarat, Bihar, Tamil Nadu, Madhya Pradesh, Rajasthan, Maharashtra and West Bengal (Figure 5.3). About a third of the workers engaged in 'raising cattle and buffaloes' sectors are only in Uttar Pradesh. However, its worker productivity (milk produced per worker) is fairly low at 5.0 tonnes per worker (Annexure 5.1). It is lower than the national average of 9.1 tonnes per worker. Figure 5.4 shows the state-wise distribution of female workers.

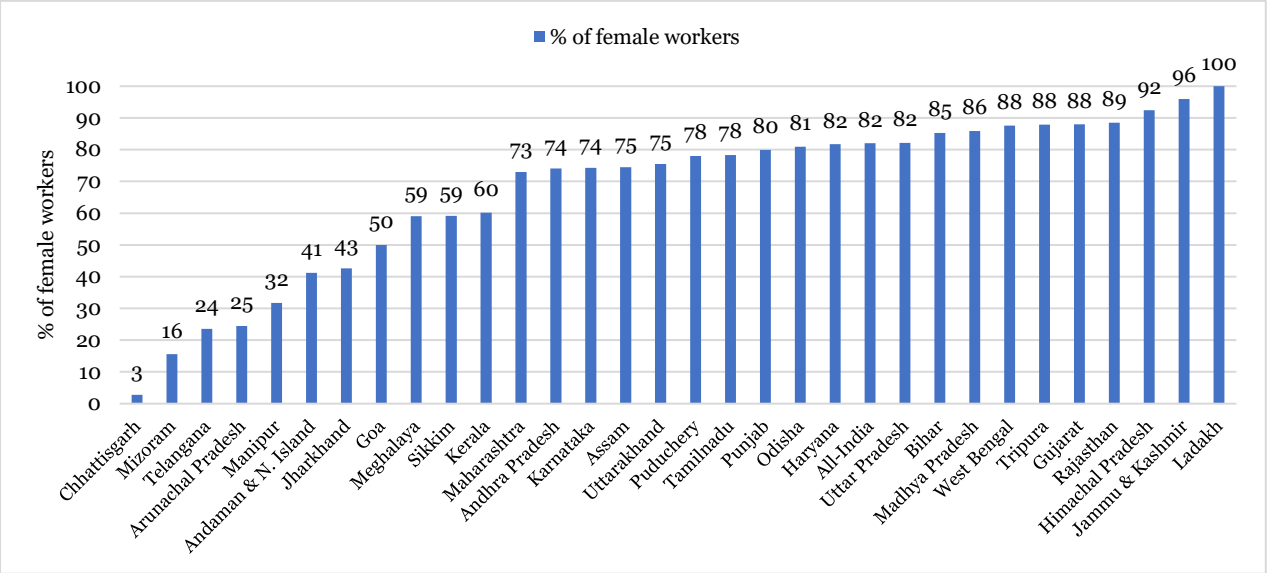
There are different varieties of cows and buffaloes—exotic cows, crossbred cows, indigenous cows, non-descript cows, indigenous buffalo, and non-descript buffalo. Exotic cows have the highest productivity amongst all the animals.

Figure 5.3: 28.3 per cent of the workers in 'raising cattle and buffaloes' sector are in Uttar Pradesh



Source: NCAER analysis from PLFS 2022–23.

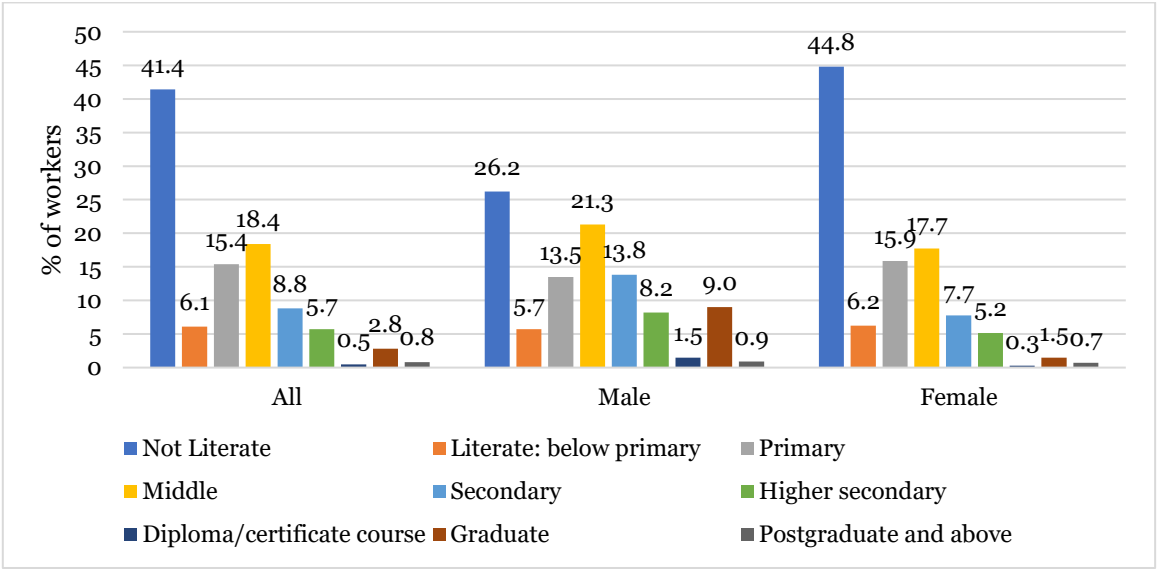
Figure 5.4: State-wise distribution of female workers engaged in 'raising of cattle and buffaloes', 2022–23 (%)



Source: NCAER analysis from PLFS 2022–23.

c. ***Education Level***: A large share of the workers is not literate (41.4 per cent). More female workers are not literate as compared to male workers (Figure 5.5). 99 per cent of the workers, neither male nor female have technical education. 1.4 per cent of workers have received formal vocational training and 29.5 per cent have received non-formal vocational training. 1.8 per cent of male workers have received formal vocational training. 1.4 per cent of female workers have received formal vocational training.

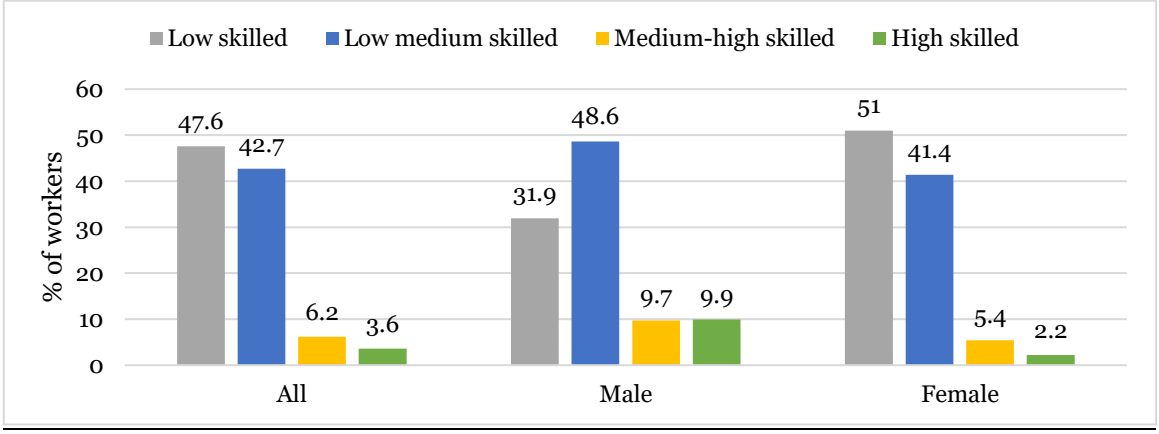
Figure 5.5: Educational attainment of workers (aged 15+) engaged in 'raising cattle and buffaloes' (%), 2022–23



Source: NCAER analysis from PLFS 2022–23.
Note: Not Literate includes data from the following four categories - Not literate, Literate without formal schooling: EGS/ NFEC/ AEC, TLC and not literate Others.

d. ***Skills***: The sector is classified by low skills (Figure 5.6). A larger proportion of male workers are low-medium skilled as compared to women workers who are low-skilled. The share of female workers in low-skilled, low-medium skilled, high-skilled and high-medium skilled are 88 per cent, 80 per cent, 72 per cent and 50 per cent respectively.

Figure 5.6: Majority of workers in the 'raising of cattle and buffaloes' sector are low skilled (aged 15+), 2022–23

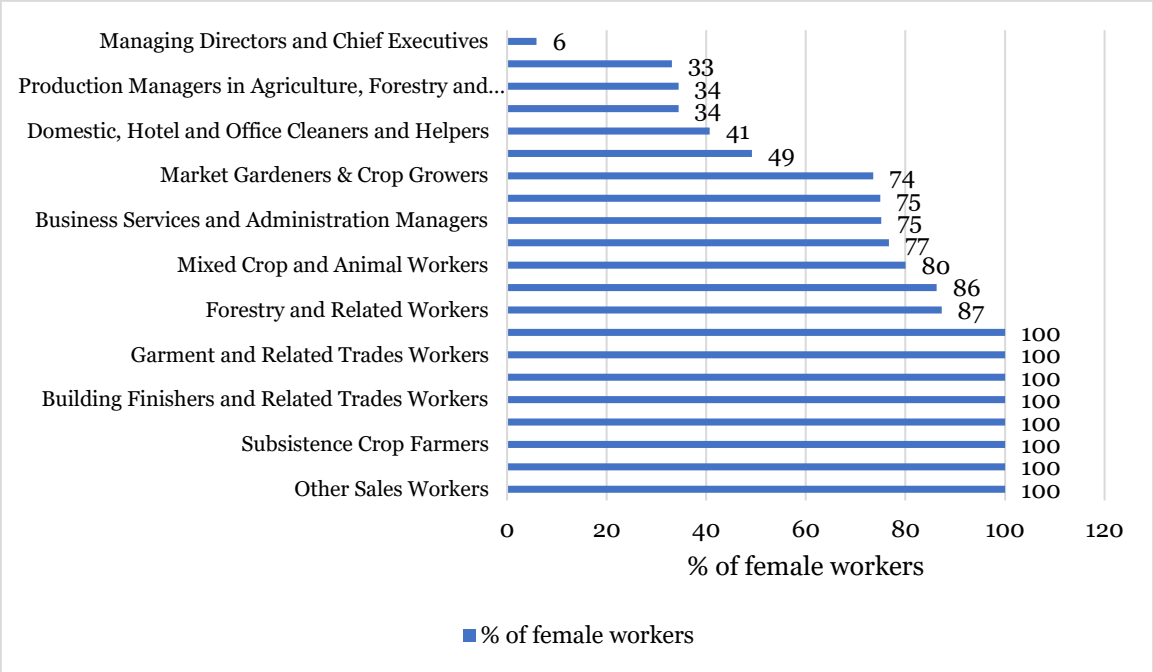


Source: NCAER analysis from PLFS 2022–23.
Note: Look at Annexure 4.2 for the definition of skills.

e. ***Occupations***: 87 per cent of the workers are animal producers. 89 per cent of the female workers are animal producers. However, an examination of occupations at the 3-digit level from the PLFS shows high concentration of women in several other job roles (Figure 5.7). Most interesting, while this sector is female-dominated but the share of females in leadership roles such as 'Managing Director & CEOs' is very small.

People engaged in a sector can be shown as number of jobs versus number of workers. As mentioned earlier, jobs as per PLFS is defined as sum of workers engaged in the sector in their principal capacity and subsidiary capacity. Workers in a sector can be shown as sum of workers engaged in the sector in their principal capacity and those workers who are engaged in the sector in their subsidiary capacity and they not having any working engagement in their principal capacity. In the sector, 'raising of cattle and buffaloes' sub-sector, percentage of female jobs being more than percentage of female workers (73 per cent vs 64 per cent) shows that relatively more female workers than male workers are engaged in the sector in their subsidiary capacity who have also working engagement in their principal activity.

Figure 5.7: Percentage of female workers (aged 15+) in 'raising cattle and buffaloes' sector across occupations, 2022–23



Source: NCAER analysis from PLFS 2022–23.

f. ***Engagement Status:*** Majority of the workers are self-employed in this sector (Table 5.1). 76.9 per cent of workers are self-employed and 0.7 per cent of workers are employers and 21.5 per cent are unpaid family workers. The corresponding statistics for male workers are 67.6 per cent, 2.5 per cent and 25.1 per cent respectively. The corresponding statistics for female workers are 79.0 per cent, 0.3 per cent and 20.7 per cent respectively. 0.7 per cent of workers are employed as regular salaried workers and this is 100 per cent of males. A very small proportion of workers work as casual wage workers (0.2 per cent) and this is also 100 per cent of male workers.

Table 5.1: Engagement status (%) of workers in 'raising of cattle and buffaloes'

Sector	All Workers (aged 15+)					
	Self-employed			Regular salaried/ wage employee	Casual wage labour	Total
	Own account worker	Employer	Worked as helper in h.h. enterprise (unpaid family worker)			
Raising of cattle and buffaloes	76.9	0.7	21.5	0.7	0.2	100.0
	All Male Workers (aged 15+)					
Raising of cattle and buffaloes	67.6	2.5	25.1	3.5	1.3	100.0
	All Female Workers (aged 15+)					
Raising of cattle and buffaloes	79.0	0.3	20.7	0.0	0.0	100.0

Source: NCAER analysis from PLFS 2022–23.

5.4 Geographical Clusters

5.4.1 Definition of Clusters

Clusters are defined as non-random (Ellison and Glaeser, 1997) geographical agglomeration of firms with comparable or closely complementary capabilities (Richardson, 1972).[2] Precisely, in the geographical concentration of enterprises, specific suppliers, service providers, associated institutions, and organisations settled themselves in a certain arena that competes with each other but also co-operates themselves. The geographical proximity of units gives rise to specialised labour, develops subsidiary industries, stimulates state-of-the-art activity, and enables technological spill-overs that makes the economic and non-economic inter-firm linkages feasible.

The prospects for India's role in the dairy markets mostly hinge on its ability to improve the low productivity of its milking herd with considerable skill gaps in various categories of employment and on the growth and competitiveness of its emerging dairy product sectors. The key to productivity gains will be the continued expansion of relatively high-yielding crossbred dairy herd, along with continued growth in buffalo milk production which is the largest share of milk output. In both cases, output gains are likely to be increasingly dependent on improving the deficient supplies of feeds and enhancing genetics, both of which may provide ample trade opportunities. India's cooperative and private-sector dairy processors have, so far been successful in meeting the growing domestic demand for dairy products. In the cluster form of production, one way to reinforce competitiveness was the skill management of cluster-based dairy farming, based on the farms' production potential.

[2] Ellison, G., & Glaeser, E. L. 1997. "Geographic concentration in US manufacturing industries: a dartboard approach". *Journal of Political Economy,* 105(5): 889–927.

Richardson. G. B. 1972. "The Organisation of Industry". *The Economic Journal,* 82 (327): 883–896. September.

In this count, the strategy for cluster development by the government is intended to benefit the dairy enterprises to augment their productivity and develop advanced-level innovative products suitable for the national and international market. Michael Porter asserts that an industrial cluster is a set of industries related through buyer-supplier relationships, or by common technologies, common buyers or distribution channels, or common labour pools.[3] Such a relationship leads to improved efficiency and international competitiveness.

The idea behind the dairy farming cluster was that clustering of dairy farms, processing, commercial support services, education and extension within a restricted area that creates a more efficient regional dairy chain (Zijlstra and Lee, 2015).[4] Similar to the previous chapter, the Delgado et al. (2014) definition of clusters is used here in this chapter with the Sutawi et al. (2022) framework being adopted.[5] The cluster development framework is the same as Figure 4.9. The indicators used in estimating clusters in 'raising cattle and buffaloes' are shown in Annexure 5.2. Please note that Annexure 5.2 is indicative and not exhaustive. As there are several indicators, that are inter-aligned and non-measurable.

The Dairy Cluster Analysis offers a comprehensive assessment of the dairy industry in India through a structured approach focusing on four main pillars: institutional, business infrastructure, human resources, and government support. Each pillar is divided into sub-pillars, which are further segmented into specific indicators that reflect the operational and developmental aspects of dairy clusters across various States.

5.4.2 Methodology

A. Pillar Structuring

a. Each pillar addresses distinct aspects of the dairy sector, broken down into sub-pillars that target granular elements crucial for State-by-State evaluation.

b. Indicators under each sub-pillar provide a metric-based approach to assess different facets of dairy cluster operations and influences.

B. State Ranking based on indicators

a. States are ranked based on their performance in each indicator. These rankings are used to evaluate relative strengths and weaknesses across a standardised set of criteria.

b. For each sub-pillar, the ranks of all its indicators are averaged to compute an overall rank for each state within that sub-pillar.

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[3] Porter, M. 1998. "Clusters and the new economics of competitiveness". *Harvard Business Review*. 77–90. December.

[4] Zijlstra, J. and Lee, J. 2015. "Dairy Cluster Design for Myanmar". *Livestock Research Report 866*. Wageningen University and Research Centre.

[5] Delgado, M., Porter, M. E., & Stern, S. 2014. "Defining clusters of related industries". NBER Working Paper No. w20375. https://www.nber.org/system/files/working_papers/w20375/w20375.pdf. Boston: MA: National Bureau of Economic Research.

Sutawi, Prihartini I., Zalizar L., Wahyudi A., Hendraningsih L. 2022. "The Success Indicators of a Dairy Farming Cluster in Indonesia: A Case in Malang Regency of East Java Province". *Asian Journal of Dairy and Food Research,* 41(1): 22–27. doi: 10.18805/ajdfr.DR-242.

C. Final State Selection

a. The average rankings from each sub-pillar are used to derive a final ranking for each State under the respective pillar. This ranking represents an aggregate measure of State performance relative to the specified operational criteria of the dairy cluster.

D. Consolidation Across Pillars

a. Separate sheets are dedicated to each pillar where States are ranked per sub-pillar and an overall ranking is provided based on average values.

b. The final sheet amalgamates the State selections (final rankings) from all pillars, presenting a cohesive view. States are ranked based on their average rankings across all pillars, culminating in a final composite ranking that illustrates the comprehensive performance landscape.

Using the pillars of the indicators in Annexure 5.2, Table 5.2 reports the dairy cluster states in India by using the rank-average method.

Table 5.2: 'Raising cattle and buffaloes' clusters in India

S.No.	*State*	*Institutional*	*Business Infrastructure*	*Human Resources*	*Government Support*	*Average Ranking*
1	Karnataka	1	6	4	6	4.3
2	Maharashtra	6	1	2	15	6
3	Rajasthan	4	4	6	10	6
4	Gujarat	2	2	10	14	7
5	Bihar	7	3	3	26	9.8
6	Kerala	10	23	11	1	11.3
7	Odisha	14	16	9	7	11.5
8	Tamil Nadu	5	9	7	25	11.5
9	Uttar Pradesh	3	7	1	35	11.5
10	West Bengal	15	10	8	17	12.5
11	Madhya Pradesh	8	11	5	31	13.8
12	Chhattisgarh	17	21	18	2	14.5
13	Himachal Pradesh	20	12	15	11	14.5
14	Andhra Pradesh	16	8	17	18	14.8
15	Haryana	9	18	14	23	16
16	Assam	19	17	13	19	17
17	Jharkhand	26	13	12	20	17.8
18	Punjab	11	14	16	32	18.3
19	Uttaranchal	12	19	20	24	18.8
20	Arunachal Pradesh	33	20	23	5	20.3
21	Telangana	13	15	19	36	20.8
22	Goa	24	5	30	27	21.5
23	Tripura	25	28	22	13	22
24	Jammu & Kashmir	18	22	21	28	22.3
25	Manipur	21	24	24	22	22.8
26	A & N Islands	31	30	29	4	23.5
27	D & N Haveli	32	31	33	3	24.8
28	Meghalaya	29	35	31	8	25.8
29	Mizoram	30	34	27	12	25.8
30	Sikkim	22	27	25	29	25.8
31	Nagaland	27	36	28	16	26.8
32	Daman & Diu	36	29	35	9	27.3

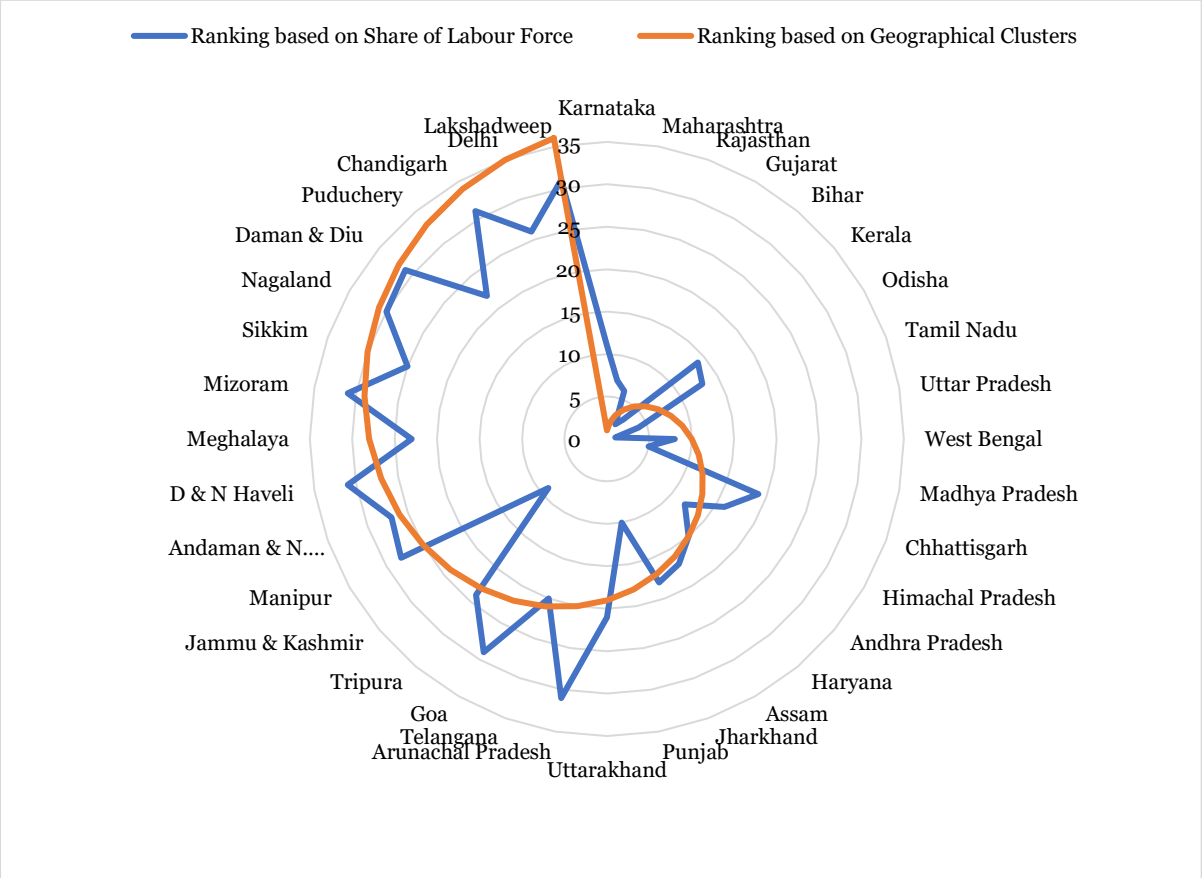
S.No.	State	Institutional	Business Infrastructure	Human Resources	Government Support	Average Ranking
33	Puducherry	23	33	26	30	28
34	Chandigarh	34	25	34	21	28.5
35	Delhi	35	26	32	34	31.8
36	Lakshadweep	28	32	36	33	32.3

Source: NCAER Computations.

This report employs a methodological approach to rank States in a quantifiable manner, highlighting key areas of performance and opportunities for enhancement within India's dairy clusters. The final rankings offer a strategic tool for comparative assessment and benchmarking of State performance in comparison to national standards.

The correlations between State-wise rankings of share of workers in this sector and rankings of geographical clusters is 0.8. Figure 5.8 shows State-wise rankings using both the variables. For majority of the States, rankings are same or similar with significant exceptions. While Maharashtra is ranked seventh in terms of share of workers, it is ranked second in terms of being a cluster. And Uttar Pradesh is ranked first in terms of share of workers but ranked ninth when looked at it from a cluster perspective. It signals relatively lower labour productivity in the State.

Figure 5.8: Rankings using share of workers and geographical clusters for the 'raising cattle and buffaloes' sector



Sources: NCAER Computations from Table 5.3 and PLFS 2022–23.
Note: Lower ranking means better performance.

5.5 Occupational Mapping

The PLFS publishes occupations at the NCO 3-digit level. The corresponding 8-digit occupational codes from the National Classification of Occupations were identified based on the researchers' knowledge, literature review, etc. (wherever feasible). Further, they were mapped to the list of job roles in Agriculture Skill Council of India (ASCI) job roles, where they could be identified. Annexure 5.3 shows the occupational mapping for the 'raising cattle and buffaloes' sector.

5.6 Stakeholders' Survey

5.6.1 Approach and Stakeholders Identification

States and districts within States have varying composition of various species of cattle and buffaloes. This requires dedicated knowledge and skilling to enhance productivity of the animal. Therefore, a bottom-up approach was used where stakeholders' survey was carried out in various districts to identify skill shortages. Specifically, four districts of Haryana namely Faridabad, Gurugram, Hisar and Karnal were selected for this study. Further, stakeholders from Karnataka, West Bengal, Rajasthan and Maharashtra were also interviewed.

Stakeholders were identified from the value chain (see Figure 5.2) and systematically covered (Table 5.3). Separate questionnaires were developed for each set of stakeholders—Ministry, Sector Skill Council, Industry Association, Farmers/FPOs, training partners, research institutes and other stakeholders. The questionnaire for the livestock sector (Questionnaire No. 3) is given at the end of the report in the questionnaires section. The total number of stakeholders interviewed are shown in Table 5.4.

Table 5.3: Stakeholders visited in Gurugram, Faridabad, Hisar, Karnal in Haryana and North 24 Parganas in West Bengal (raising cattle and buffaloes)

Stage	***Core Activities***	***Primary Stakeholders (√ indicates that these stakeholders were visited)***
Breed Selection & Rearing	Selection of high-yield breeds, cattle rearing, nutrition, and disease management.	Dairy Farmers (√), ICAR Research Institutes (√), Veterinary Universities (√), State Animal Husbandry Department (√), Livestock Feed Suppliers (√) and Veterinary Services (√)
Milk Production	Feeding, milking techniques, animal health management, and fodder cultivation.	Dairy Farmers (√), Cooperative Dairy Societies (√), Private Dairy Firms (√), Veterinary Services (√), State Animal Husbandry Department (√), Agri-tech/Dairy-tech Startups (√)
Chilling & Storage	Chilling, cold storage, and transportation of milk and dairy products.	Warehouses (√), Cold Storage Facilities (√), Dairy Cooperatives (√)
Marketing & Sales	Developing marketing strategies, distribution, and pricing of dairy products.	State Dairy Federations (√), Retailers (√), E-commerce & Online Dairy Platforms (√), Dairy-tech Startups (√)

Source: NCAER.

Table 5.4: Total number of stakeholders covered in the survey of 'raising cattle and buffaloes'

Sector		*Number of Stakeholders*
Ministry		1
Sector Skill Council		1
National-level Industry Association		1
No of Farms/Firms	Micro/Small	6
	Medium	3
	Large	6
	Total	15
No. of Placement Cells/TVET Institutions		3
Recruitment Agencies		Not Applicable
Other Stakeholders		5
Firms plus Other Stakeholders		20
Total		26

Source: NCAER.

5.6.2 Sectoral Findings about Skill Shortages and Skill Gaps from Stakeholders' Survey

The survey of the dairy and livestock sector highlighted both current and future skill shortages in key occupations such as veterinary technicians, refrigeration mechanics, dairy technologists, and dairy farm managers. These shortages stem from a combination of factors, including an outdated education and training system, industry-specific challenges, and mismatches between employer expectations and available workforce skills. While some job roles face a skills shortage due to an insufficient number of trained workers, others suffer from a skills gap, where workers lack the necessary competencies despite being employed.

A major concern in the education and TVET (Technical and Vocational Education and Training) system for dairy and livestock jobs is the outdated curriculum, which does not adequately incorporate modern dairy technologies such as automated milking systems, AI-driven cattle health monitoring, and cold chain logistics. The shortage of qualified trainers and practical training facilities further weakens the skill pipeline. Many institutions lack modern laboratories for animal breeding, milk quality testing, and refrigeration system management, making it difficult for graduates to gain hands-on experience. Moreover, weak academia-industry linkages mean that many dairy processors and large farms struggle to find workers with practical knowledge in farm management, milk processing, and quality control. The lack of structured apprenticeship and internship programmes further exacerbates the issue.

Female workforce participation in the dairy and livestock sector faces both demand-side and supply-side challenges. From the industry's perspective, jobs requiring physical labour—such as handling cattle or managing dairy processing plants—are considered less aspirational for women, and senior leadership opportunities for women in dairy management remain limited. On the supply side, cultural norms and safety concerns deter women from taking up livestock roles,

particularly in field-based operations. However, technological advancements, such as farm automation, can reduce physical labour requirements, making these jobs more accessible to women. Furthermore, improving workplace safety, offering transport, and providing permanent contracts can encourage greater female participation.

To address the skills gap, some large dairy firms and cooperative societies, such as AMUL and Mother Dairy, have initiated their own training academies to develop dairy technologists and farm managers. Best practices from leading firms show that providing permanent contracts, health insurance, and structured career growth opportunities improves workforce retention. Additionally, introducing specialised training programmes for women, offering transport facilities, and implementing better workplace safety policies can further enhance female participation in the sector.

The findings highlight the need for expanding skill training programmes, incorporating modern dairy technologies into curricula, strengthening industry-academia partnerships, and addressing gender-specific barriers in the workforce. Targeted policy interventions, such as apprenticeship mandates, summer internships, and skill development programmes focusing on women, can help bridge the existing skill gaps and prepare the dairy and livestock sector for future labour market demands.

The fragmented nature of the dairy sector poses a significant challenge in identifying clusters, as regional variations add complexity to the research process. Moreover, the informal structure of the sector makes it difficult to quantify workforce participation, leading to a lack of official data and records. Additionally, inadequate infrastructure and logistical constraints have stagnated productivity, resulting in inefficiencies across dairy farming operations. Lastly, there is an urgent need to establish structured educational and training programmes that align with future job demands by integrating advanced technical skills into their curricula.

There are three key findings from stakeholders' survey about job roles-ones which require re-skilling & upskilling, new and emerging job roles and job roles which are difficult to fill. They are discussed in detail below.

1. Job roles which require re-skilling and upskilling:
    - Milker (not shown in Table 5.5))[6]
        - Milking the cattle as required
        - Collecting various feed mixes and feeding the animals
        - Regulating the timing for milking
        - Cleaning and disinfecting buckets and other containers used in milking
        - Tying the hind legs of animals and washing their hindquarters with chlorinated water
        - Cleaning and disinfecting hands and udder with plain chlorinated water and massaging them by hand
        - Pressing udders alternatively with fingers to extract maximum milk
        - Stimulating the flow of milk from udder by repeated supply of feed
        - Transferring milk to a specified storing place
        - Treating udder and other minor injuries by applying antiseptic powder, ointment, etc.
        - Selling milk in the market
        - Preparing ghee, butter, and cream

[6] National Career Service website. https://www.ncs.gov.in/Pages/default.aspx.

This has been a traditional job role where the skills were taught within families but with youth aspiring for jobs outside the livestock sector, it has become challenging to fill these roles. Therefore, it is recommended that these traditional job roles need to be taught in formal settings with Recognition of Prior Learning and bridge education and training playing a major part. The knowledge and skills required are the following:

- The minimum education requirement is 5th standard.
- Animal husbandry which include the following are required:
  - Understanding the breeding and genetics of dairy breeds;
  - Nutrition Management: Knowledge of balanced diets to ensure optimal milk production and animal health;
  - Health Management: Skills in identifying and treating common diseases like mastitis, which can affect milk quality
- Physical skills
- Cognitive skills including communication skills.

2. New & Emerging Job Roles focussing in the 'sunrise' aspects of the sector: Scrap Manager is someone who manages all aspects of scrap materials generated from raw material process waste across organisation and ensures inventory control, vendor management, and revenue maximisation. Qualifications required are B.Tech. in Dairy Technologist.
3. Job Roles which are deemed as difficult to fill: The top four job roles that are difficult to fill are shown in Table 5.5 and the rest are explained below.

- Veterinary Technician/Assistant: The National Career Service defines two types of Veterinary Assistants—Field and Clinical.[7]
  - The tasks a Veterinary Field Assistant is expected to perform include:
    - Assisting veterinarians in controlling and restraining domesticated farm/wild animals and poultry
    - Implementing regular preventive animal health care programme
    - Assisting in provisional diagnosis of common animal diseases (including poisoning and injury)
    - Providing curative treatment for common animal diseases
    - Conducting minor surgical procedures in the field
    - Assisting government agencies in animal disease control
    - Assisting in animal identification, data collection, and documentation of practices (including socio-economic aspects)
    - Assisting in implementation of veterinary public health and other regulatory activities
    - Assisting in implementation of animal breeding services
  - The tasks a Veterinary Clinical Assistant is expected to perform include:
    - Implementing regular preventive animal health care programme
    - Assisting in provisional diagnosis of common animal diseases
    - Providing curative treatment for common animal diseases
    - Assisting during veterinary surgery in hospital/clinic setting
    - Providing companion animal care
    - Assistance in veterinary hospital/clinic management
    - Conducting common laboratory tests on animals
    - Implementing veterinary public health and other regulatory activities
    - Implementing animal breeding services

[7] National Career Service website. https://www.ncs.gov.in/Pages/default.aspx.

    - Assisting in animal welfare, breed conservation and disaster management
    - Assisting in livestock farm management
- Mechanic-Refrigeration and Air Conditioning:[8] The tasks involve the following:
    - Installing and repairing refrigeration or air conditioning units
    - Replacing defective parts, re-seating valves, refitting coils, insulating, requiring electrical connections, soldering, etc.
    - Installing at site assembled air conditioning unit and refrigerators giving necessary power connections
    - Making changes to units as necessary
    - Examining faulty equipment
    - Dismantling equipment if required
    - Replacing or repairing defective parts to units by re-seating valves, refitting coils, re-insulating system, etc.
    - Over hauling and reassembling units after cleaning components
    - Replacing defective or worn out parts of pumps, compressors, motors, etc.
    - Removing faulty sealed units or sub-units of refrigerators or air conditioning plants
    - Conducting vacuum and pressure test of pipe lines and charging system with fresh refrigerant
    - Setting plant to desired cooling conditions, preventing leakage and ensuring attainment and maintaining required temperature
    - Getting burnt out motors or generators repaired and installing repaired ones to plant giving necessary electrical connections
- Dairy Technologist:[9] The tasks include:
    - Applying principles of bacteriology, chemistry, physics, engineering and economics to produce milk and milk products
    - Developing new and improved methods in production, preservation and utilisation of milk, cheese, ice-cream, etc.
    - Conducting experiments in preventing bacterial increase in milk during handling and processing
    - Improving pasteurisation methods
    - Designing better packaging materials, dairy equipment or supplies
    - Managing sanitation, storage, etc. according to the product, such as ice-cream, cheese, etc.
- Manager-Dairy Farm[10]: The tasks include:
    - Managing the dairy farm on behalf of the employer
    - Producing milk, butter, ghee, etc.
    - Supervising selection and purchase of animals, in consultation with their employer
    - Making proper arrangements for housing, feeding and treatment of milch animals
    - Pairing animals for breeding on basis of pedigree
    - Arranging artificial insemination for the development of good breed
    - Taking proper care of animals during birth of young

[8] National Career Service website. https://www.ncs.gov.in/Pages/default.aspx.

[9] Ibid.

[10] Ibid.

    - Ensuring that hygienic methods are observed
    - Arranging the transportation and marketing of the products
    - Controlling office and field staff, and co-ordinating their work
- Sales manager (not shown in Table 5.5):[11] A sales manager in the dairy farm industry, as classified by the National Career Service (NCS), is responsible for managing and overseeing all aspects of sales and marketing activities, including building relationships with customers, achieving sales targets, and ensuring customer satisfaction. They should have a Bachelors in Commerce and good communication skills.
- Farm Worker (not shown in Table 5.5): A farm worker is someone who works on the farm. The workers are involved in the production process of milk and packaging it. They have to ensure that cows are well-fed, cut fodder, clean barns and the animals are not injured or wounded. Their education level can be below Class X. It is difficult to find young farm workers as youth are not aspirational and churning is also quite high. One organic farmer reported that 30 per cent of their employees were farm workers. One farm said that digital communication skills, i.e., how to use mobiles and how to make good reels on social media are additional benefits. There are spatial gaps. It was difficult to find workers in Uttar Pradesh but not in Uttarakhand. Basically, closer to the city, you get, it is harder to find farm workers. Since the farm was an organic one, they preferred to use hands versus machinery. Another farmer reported the same problem. This again points to the issue that there are no takers for traditional jobs. Families cannot be relied upon to teach them and one need to teach traditional skills in formal settings.
- Delivery Worker: They deliver milk in the morning at 4 a.m., i.e., provide transport. They are in-between phases of life either unemployed or studying. In one organic farm, 25 per cent of their employees (30 workers) were delivery workers and all of them were part-time.

[11] National Career Service website. https://www.ncs.gov.in/Pages/default.aspx.

Table 5.5: Assessment of current and future skills shortage for top five job roles in 'raising cattle and buffaloes'

Items	***Veterinary Technician/Assistant***	***Mechanic—Refrigeration and Air Conditioning***	***Dairy Technologist***	***Manager—Dairy Farm***
NCO Code	324	712	214	131
NCO 3/8-digit (QP code)	3240.9900 (AGR/Q4801; AGR/Q4802)	7127.0100 (FIC/Q9502)	2141.1900	1311.1400 (AGR/Q4101)
Match from Job Projections (612, 521, 632, 613 and 611) @				
No. of stakeholders which mentioned this	12	14	13	15
Location of firms/farms	Karnal, Hisar & Faridabad, Haryana; Pune & Kolhapur, Maharashtra; Jodhpur, Rajasthan and; North 24 Parganas, West Bengal	Karnal, Hisar & Faridabad, Haryana; South Bengaluru, Karnataka; Pune & Kolhapur, Maharashtra; Mohali, Punjab; Jodhpur, Rajasthan and; Bareilly, UP	Karnal, Hisar & Faridabad, Haryana; South Bengaluru, Karnataka; Pune & Kolhapur, Maharashtra; Mohali, Punjab; Jodhpur, Rajasthan and; Bareilly, UP	Karnal, Hisar & Faridabad, Haryana; South Bengaluru, Karnataka; Pune & Kolhapur, Maharashtra; Mohali, Punjab; Jodhpur, Rajasthan and; Ghaziabad & Bareilly, UP
Average monthly income (Rs.)	25 to 30,000	35 to 40,000	55 to 60,000	50 to 60,000
Educational Qualifications	Bachelor of Veterinary Science/Diploma Holder/NSQF Aligned Course	Industrial Training Institute (ITI) and NCVT/SCVT certification	B.Tech/M.Tech degree from NDRI/CCSHAU etc.	Management degree in Dairy Business/Diploma Holder/NSQF Aligned Course
Skills required at the competency level (3 and more)	**Cognitive Skills**: Reading, writing, numeracy, digital Skills, Resource Management (Entrepreneurship skills) **Socio-emotional Skills:** Extraversion **TVET**: Animal behaviour, breeding, disease awareness and Application of medicine and surgery	**Cognitive:** Reading, writing, numeracy and digital skills **Socio-emotional Skills:** Agreeable **TVET**: • Troubleshoot and repair electrical and air-filled control systems & its management Bulk cooling management	**Cognitive Skills:** Reading, writing, numeracy and digital skills **Socio-emotional Skills**: Conscientiousness **TVET**: • Applying chemistry and microbiology, to dairy production processes to ensure quality and efficiency Expertise in techniques to enhance milk production and preserve milk to extend shelf	**Cognitive Skills**: Reading, writing, speaking, knowledge of local language and English/Hindi/local language, digital skills, independent learner, active listening, creativity, learning strategies (learn & train their own staff), judgement & decision-making, resource management (time management, financial & resource management),

Items	*Veterinary Technician/Assistant*	*Mechanic—Refrigeration and Air Conditioning*	*Dairy Technologist*	*Manager—Dairy Farm*
			life and maintain nutritional value. Awareness of modern technologies	communication skills (effectively communicate with employees, suppliers, buyers, and customers to build relationships and ensure smooth business operations) **Socio-emotional Skills**: Extraversion, Agreeable and Emotional Stability **TVET**: Knowledge about the sector
Skills Shortage	Yes	Yes	Yes	Yes
Skills Gap	No	Yes	No	No
Relevance of TVET System	Good quality	Practical skills missing; skills mismatch	Good quality	Good quality
Gender (Challenges)	No issue	Not aspirational	No issue	No issue
Challenges Faced by Industries in Meeting Skill Requirements	Prevalence of unqualified workers	MSMEs face challenges because they do not have the capacity to skill	Finding workers	Finding workers
Industry-specific interventions that facilitate skill & capacity development (best practices)	Large and new-age farms are opening their own veterinary units	None	Research & Development on farms	On-job training given
Policy Recommendations	**Skill Training Programme**: Needs to be expanded **Curriculum Development**: Entrepreneurship skills need to be added to curriculum **Gender**: Maybe encouraged with additional socio-emotional skills **Skill Initiatives**: Special focus for women	**Skill Training Programme**: Needs to be expanded **Curriculum Development**: Practical skills to be made mandatory; curriculum needs to be aligned with present needs **Gender**: Maybe encouraged **Skill Initiatives**: Apprenticeships should be made mandatory	**Skill Training Programme**: Needs to be expanded **Curriculum Development**: Incorporate modern technologies in curriculum **Gender**: Maybe encouraged **Skill Initiatives**: Summer internships are recommended	**Skill Training Programme**: Needs to be expanded; **Curriculum Development**: Socio-emotional skills need to be incorporated in the curriculum **Gender**: Maybe encouraged **Skill Initiatives**: Special training for women

Source: NCAER Conceptualisation.
Notes: @ Pink shade indicates no match between I-O quantitative top 5 occupation projections and survey-based top 5 occupation projections. Not matching makes sense as the I-O analysis, projects top 5 job occupations where most of the workers are there. However, in the survey, stakeholders were asked that in which job roles, i.e., they are trying to hire people but are not able to hire. Plus, technological changes have created new job roles.

5.7 Recommended Methodology

The development of India's dairy sector requires a bottom-up (district-wise) strategy, given its diverse agro-climatic and socio-economic landscape. A district-wise approach is essential to address regional variations in dairy production, workforce capabilities, and infrastructure gaps. This necessitates a multi-pronged strategy combining secondary data analysis, stakeholder consultations, and labour market assessments to ensure evidence-based policy interventions.

A rigorous secondary data analysis using statistics at the Central and state levels can provide valuable insights into regional needs. The Ministry of Statistics and Programme Implementation (MoSPI) publishes data on the *Situation Assessment of Farmers* and the value of agricultural output, which can help identify district-level production trends and economic conditions. Additionally, reports from the Ministry of Fisheries, Animal Husbandry & Dairying, including *Animal Husbandry Statistics* and *Annual Reports*, along with State government publications, can offer critical information on livestock population, milk yield, and sectoral investments.

However, beyond secondary data, stakeholder consultations through Focus Group Discussions (FGDs) are crucial for capturing qualitative aspects such as farmer challenges, technology adoption, and skill gaps. These discussions can provide nuanced insights into regional constraints in dairy production and processing, allowing for more targeted interventions.

A key area requiring in-depth assessment is workforce composition, skill shortages, and emerging employment trends in the dairy sector. An Occupational-Wage-Employment Survey can provide critical insights into new and evolving roles such as dairy technologists, farm management specialists, and veterinary service providers. This organised and formal part of the dairy sector may be included in the OWES sector. Additionally, technological advancements in artificial insemination, feed optimisation, disease management, and precision dairy farming have created demand for specialised skill sets. However, existing skill shortages—especially in refrigeration mechanics for milk preservation, dairy processing, and cold-chain logistics—highlight the need for targeted skill development programs.

Furthermore, vacancy surveys can be used to assess real-time workforce shortages in critical areas such as dairy farm management, veterinary services, and milk processing.

Moreover, Big Data analytics can be leveraged to track labour trends, workforce mobility, and skill utilisation in commercial dairy farms, processing units, and retail dairy chains. This can provide policymakers with real-time insights into employment patterns and help bridge regional mismatches in skill availability and industry demand.

By integrating data-driven decision-making with skill enhancement and inclusive employment strategies, the dairy sector can optimise productivity, address labour market asymmetries, and enhance job creation—particularly for women and marginalized communities. A structured, evidence-based approach that combines statistical insights with qualitative assessments can drive policies that are not only responsive to local needs but also aligned with the broader vision of a modern, inclusive, and sustainable dairy ecosystem.