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Aastha Chouhan
Department of Agribusiness and Rural Management, Indira Gandhi Krishi Vishwavidyalaya, (IGKV), Raipur, Chhattisgarh, India

Dr. Hulas Pathak
Department of Agribusiness and Rural Management, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh, India

Corresponding Author:
Aastha Chouhan
Department of Agribusiness and Rural Management, Indira Gandhi Krishi Vishwavidyalaya, (IGKV), Raipur, Chhattisgarh, India

Towards optimal feed formulation for improved milk production: Lessons from Raigad district, Maharashtra

Aastha Chouhan and Dr. Hulas Pathak

Abstract
This study examines the dynamics of the cattle feed market in Raigad district, Maharashtra, during 2023-24, focusing on demand patterns, market trends, and growth prospects. Maharashtra ranks 7th in India with a total livestock of 3.31 crore, contributing significantly to the economy. Livestock husbandry is crucial for rural livelihoods, providing income, employment, nutrition, and manure. The study utilized survey data and market analysis to assess the composition and performance of different cattle feeds. The results indicate that the market for compound animal feed is maturing, with 56.5% of the market consisting of pellet-type feeds, mainly supplied by Occamy Bioscience. Mash-type feeds account for 28.5%, with other types making up the remaining 15%. Analysis of milk production costs across different breeds highlighted the need for efficient feeding strategies. Various feed combinations were tested, showing significant impacts on milk yield and emphasizing the importance of tailored nutrition plans. The study concludes that understanding local feed preferences and production capabilities is essential for optimizing livestock productivity. Modern techniques like silage making can further reduce costs and improve dairy management. These insights are crucial for supporting the sustainable growth of the dairy industry in Raigad district and beyond.

Keywords: Raigad, livestock feed, Occamy bioscience, market trends, dairy industry

Introduction
The livestock feed market in Raigad district is a crucial element of the local agricultural economy, significantly influencing livestock productivity and the livelihoods of farmers. Situated in the Konkan region of Maharashtra, Raigad's agricultural landscape is diverse, with livestock farming serving as a vital source of income for many rural households [1]. The district's proximity to major urban centers like Mumbai further accentuates its strategic importance in the regional agribusiness landscape [2]. Ensuring the quality and availability of livestock feed is therefore essential for the sustainability of livestock farming in Raigad. Feed quality plays a pivotal role in livestock health and productivity. High-quality feed ensures optimal growth, enhances immunity, and maximizes productivity, which directly impacts farmers' economic outcomes. Poor-quality feed, on the other hand, can lead to health issues, reduced productivity, and increased disease susceptibility in livestock, adversely affecting farmers' profitability [3, 4]. For the farmers in Raigad, a consistent supply of nutritious feed is vital. Understanding the dynamics of the livestock feed market is essential to optimize feed utilization, improve livestock productivity, and enhance the economic resilience of farming communities.

The primary objective of this research is to systematically study the dynamics of the livestock feed market in Raigad district, with an in-depth analysis of current demand patterns, market trends, and growth prospects, particularly focusing on the nutritive value of feed supplements. This study aims to provide actionable insights to enhance feed quality and availability, thereby boosting livestock productivity and farmer incomes. The specific objectives include assessing the current demand patterns for livestock feed, analyzing market trends to identify key drivers and challenges, evaluating the growth prospects of the livestock feed market, and emphasizing the importance of feed supplements' nutritive value in enhancing livestock productivity. By addressing these aspects, the study aims to fill critical knowledge gaps and offer strategic recommendations to stakeholders in the livestock feed industry, including farmers, feed

manufacturers, and policymakers. Globally, the livestock feed industry is dynamic and rapidly evolving, driven by the increasing demand for animal protein and the need for sustainable agricultural practices [5]. Reports indicate that the global feed market is projected to grow significantly, with a notable increase in the production and consumption of compound feeds. Technological advancements, growing awareness about animal nutrition, and the rising adoption of precision feeding techniques are key factors shaping this industry. According to the Food and Agriculture Organization (FAO), the global livestock sector is under increasing pressure to improve efficiency and reduce environmental impacts, further highlighting the importance of high-quality feed [6, 7]. India, as one of the largest milk producers globally, holds a significant position in the livestock feed market. The dairy sector is a major contributor to India's agricultural GDP, and the demand for high-quality feed is substantial to support the large and diverse livestock population [8]. The Indian livestock feed market is characterized by a mix of traditional feeding practices and modern feed supplements, reflecting the diversity of farming systems across different regions [9]. This unique blend offers both opportunities and challenges in ensuring the availability of nutritious feed to enhance livestock productivity.

Several studies have examined the livestock feed markets in various regions of Maharashtra, providing valuable insights into the sector's dynamics. Research has shown that feed quality is critical for livestock productivity and farmer incomes. Studies conducted in different districts have highlighted that the availability and affordability of quality feed are major concerns for farmers [10]. Additionally, research indicates that a lack of awareness about the benefits of feed supplements often leads to suboptimal feeding practices [11]. Despite these insights, significant gaps remain in understanding the livestock feed market in Raigad district specifically. Most existing research has focused on broader regional or state-level analyses, leaving a gap in localized studies that address the unique conditions and challenges faced by farmers in Raigad. Moreover, there is limited research on the specific impact of feed supplements' nutritive value on livestock productivity in this region. Addressing these gaps is essential to develop targeted interventions to improve feed quality and availability, thereby enhancing the overall efficiency and profitability of livestock farming in Raigad.

To address these research gaps, this study provides a comprehensive analysis of the livestock feed market in Raigad district, focusing on current demand patterns, market trends, and growth prospects. By emphasizing the nutritive value of feed supplements, the research aims to highlight critical factors influencing livestock productivity and farmer livelihoods. This localized approach offers nuanced insights directly applicable to the specific context of Raigad, enabling the development of more effective strategies to support the district's livestock farming sector.

Methodology

Data Collection

The data collection for this study involved both primary and secondary methods to ensure comprehensive and accurate insights into the cattle feed market dynamics in Raigad district.

Primary Data Collection

The primary data was collected through surveys and interviews conducted with dairy farmers across various talukas in Raigad district, including Panvel, Pen, Roha, Murud, and Alibagh. These surveys aimed to gather detailed information on cattle feed usage and milk production patterns. In addition to individual interviews, focus groups were organized with dairy farmers and feed manufacturers. These focus groups provided a platform for discussing preferences, challenges, and emerging trends in cattle feed consumption. This qualitative approach allowed for a deeper understanding of the factors influencing feed choices and the overall satisfaction with different feed types.

Secondary Data Collection

Secondary data was obtained from several reputable sources to complement and validate the primary data. Statistical data was sourced from the Maharashtra Department of Statistics [12], which provided essential information on livestock population, feed consumption patterns, and the economic contributions of the livestock sector. Additionally, market reports from organizations such as the Compound Livestock Feed Manufacturers Association (CIFMA) of India [13], National Dairy Research Institute (NDRI) Annual Report [14] and various market research firms were utilized. These reports offered insights into the broader feed market, including production volumes, market trends, and growth projections.

Data Analysis

The analysis of the collected data was conducted using both descriptive and comparative statistical methods to derive meaningful conclusions.

Descriptive Statistics

Descriptive statistics were used to calculate percentages, averages, and totals, providing a clear understanding of the distribution and consumption of different feed types (pellet, mash, and other forms). This involved analysing the contribution of each feed type to the total feed market, identifying the most commonly used feeds, and understanding their market share. These statistics helped in painting a comprehensive picture of the current state of the cattle feed market in Raigad district.

Comparative Analysis

To assess the impact of different feed types on milk production, a comparative analysis was performed across the various talukas. The milk production data was compared based on the type of feed used, including dry fodder, green fodder, concentrates, and supplements such as Bovi booster. This analysis involved creating tables and graphs to visualize the relationship between feed types and milk yield. By comparing these variables, the study aimed to identify which feed regimens were most effective in enhancing milk production, thereby providing valuable insights for dairy farmers on optimizing their feeding strategies.

Results and Discussion

Maharashtra ranks 7th in India with a total livestock of 3.31 crore in 2019, contributing over 1.61% to the country's economy. Livestock husbandry is the backbone of rural India, providing income, employment, nutrition, and manures for the poor. The cattle feed industry, which is evolving into an organized sector, has high potential for growth in Maharashtra and Raigad districts. Factors such as shrinking open land for cattle grazing and the introduction of high milk-producing cattle breeds may increase demand for cattle feed.

Table 1: Composition of Cattle Feed Market in Raigad District

S.No.	Name of the Cattle Feed Manufacturer [Brand]	Pellet type feeds [in %]	Mash type feeds [in %]	Rest of the Market [in %]
1	MFPL [Maha Feed private Limited]	9.50	4.50	[All other types of Cattle Feed products are included under this category].
2	Godrej Agrovet Pvt Ltd.	15.25	6.50	
3	Venky's brand	3.50	4.00	
4	Chambal Feeds	2.25	3.25	
5	Uniray Vet	3.50	4.25	
6	Ridhi Sidhi Cattle Feed	5.00	6.00	
7	Occamy Bioscience Pvt Ltd.	17.50	-	
	Total	56.50	28.50	15.00

[**Source:** Survey Data of Maharashtra, Department of Statistics]

As per Table 1, less than one-third of consumers of branded cow feed products use mash-type goods, while up to 56.50% use pellet-type products. The market is nearing maturity, with ready-made compounded cattle feeds being well-absorbed. The contribution of feed and fodder is up to 50% towards livestock productivity and production. The study found that 27.75% give conventional/natural and branded feed, and 29.75% give all categories of feeds as shown in Figure 1. The cost of milk production per litre of milk varies across milch species, with the highest cost for local cow followed by buffalo and crossbred. Crossbred cow and buffalo milk production yields positive returns, while local cow milk production provides negative returns. To reduce milk production costs, dairy farmers should adopt new technologies such as silage making and urea treatment to get fodder at reasonable prices. This could increase the efficiency of dairy farmers in milk production, improve health care and breeding facilities, and manage dairy animals better.

Fig 1: A) An example of mixed cake prepared by a farmer for use as feed. B) Maize and other grain pellets utilized by select farmers. C, D) Farmers relying solely on green and dry fodders. E, F) Packaging and distribution unit of Occamy Bioscience feed, along with some of its distributors.

Table 2: Demand of different feed processing ingredients quantity in Maharashtra

S.No.	Ingredients type	Amount [tonnes]
1	Maize	141,973
2	Ground nut cake	45,686
3	Soyabean cake	74,480
4	Linseed cake	21,544
5	Sunflower	46,264
6	Wheat bran	67,816
7	Cotton seed cake	23,978
	Total	381,741

The demand and supply dynamics of livestock feed ingredients are crucial for understanding the composition and performance of feed in the cattle industry. Among the concentrate feed ingredients, coarse grains like maize, sorghum, bajra, and other millets hold a primary position. These grains are complemented by cereal byproducts as shown in Table 2, such as barns and polish, as well as various oil meals including groundnut cake, mustard cake, coconut cake, soybean meal, cottonseed meal, and sesame cake, which form the bulk of concentrate requirements. Additionally, various agro-byproducts and unconventional products, such as molasses, distillery waste, wastes and byproducts from the bread/biscuit industries, breweries, hotels, tamarind seed powder, mango seed kernel, and Sal seed meal, are also used either directly as cattle feed or in the manufacture of cattle feed concentrates. The major ingredients used to formulate compound feed for livestock include primary grains such as maize and sorghum, flour processing by-products like wheat bran, wheat shorts, and rice bran, and various oilseed cakes including soybean meal, niger seed cake, linseed cake, groundnut cake, cottonseed cake, and sesame seed cake. Other additives, including molasses, vitamins, minerals, amino acids, and premixes, are also incorporated to boost production. These ingredients, demanded by the feed industry in 2020/21, ensure a relatively consistent nutrient composition across different feeds, contributing to the maintenance of cattle health. However, variations in composition, texture, and

other physicochemical aspects of the feed can significantly affect milk production. Table 3 and Table 4 along with the respective plots (Figure 2 and 3), depict the effects of different feed compositions on milk production. These tables and plots show how changes in feed types and their nutritional makeup can lead to variations in milk yield, emphasizing the importance of carefully selecting and balancing feed ingredients to optimize production outcomes. Overall, understanding the demand and supply dynamics of these feed ingredients is essential for formulating effective feed strategies that enhance livestock productivity and health.

Table 3: Outcome of Feed on Milk Production of Cow per Day in Litres in Raigad District

Villages	Dry fodder	Green fodder	Dry fodder+ Green fodder	Concentrate	Dry fodder+ Concentrate	Green fodder+ Concentrate	Others (Bovi Booster)
Outcome of Feed on Milk Production of Cow per Day in Litres in Panvel Taluka							
Village 1	2	3	5.5	4	6	7.5	8.5
Village 2	1.5	2.5	5	3.5	5	7	8
Village 3	2	3	5	4	5.5	7	8
Village 4	2	2.5	5.5	4	5.5	7.5	8
Total	7.5	11	21	15.5	22	29	32.5
Average	1.875	2.75	5.25	3.875	5.5	7.25	8.125
Outcome of Feed on Milk Production of Cow per Day in Litres in Pen Taluka							
Village 1	2	1.5	3.5	3.5	5.5	5	9
Village 2	3	2	5	4	3.5	3.8	9.5
Village 3	2.5	2.5	3.5	4	6.5	6.5	9.5
Village 4	3	3	6	3	6	6	9.5
Total	10.5	9	18	14.5	21.5	21.3	37.5
Average	2.625	2.25	4.5	3.625	5.375	5.325	9.375
Outcome of Feed on Milk Production of Cow per Day in Litres in Roha Taluka							
Village 1	2.5	3.5	6	5	7.5	**8.5**	**7.5**
Village 2	2	1.25	3.25	4	6	5.25	7
Village 3	3	2.5	5.5	5	8	7.5	6.5
Village 4	2	2.5	4.5	3.5	5.5	6	6
Total	9.5	9.75	19.25	17.5	27	27.25	27
Average	2.375	2.43	4.812	4.375	6.75	6.81	6.75
Outcome of Feed on Milk Production of Cow per Day in Litres in Murud Taluka							
Village 1	2	3.5	5.5	4.5	6.5	8	5.5
Village 2	3	3.5	6.5	4	7	7.5	5
Village 3	2.5	4	6.5	3	5.5	7	4.5
Village 4	4.5	3.5	8	4	8.5	7.5	10
Total	12	14.5	26.5	15.5	27.5	30	25
Average	3	3.625	6.625	3.875	6.875	7.5	6.25
Outcome of Feed on Milk Production of Cow per Day in Litres in Alibagh Taluka							
Village 1	1.75	3.5	5.25	4	5.75	7.5	8
Village 2	7.5	6	13.5	3.5	11	9.5	8.5
Village 3	6.5	3.5	10	4.5	11	8	8.5
Village 4	5.5	3	8.5	4.5	10	7.5	8.5
Total	21.25	16	37.25	16.5	37.75	32.5	33.5
Average	5.312	4	9.312	4.12	9.43	8.125	8.375

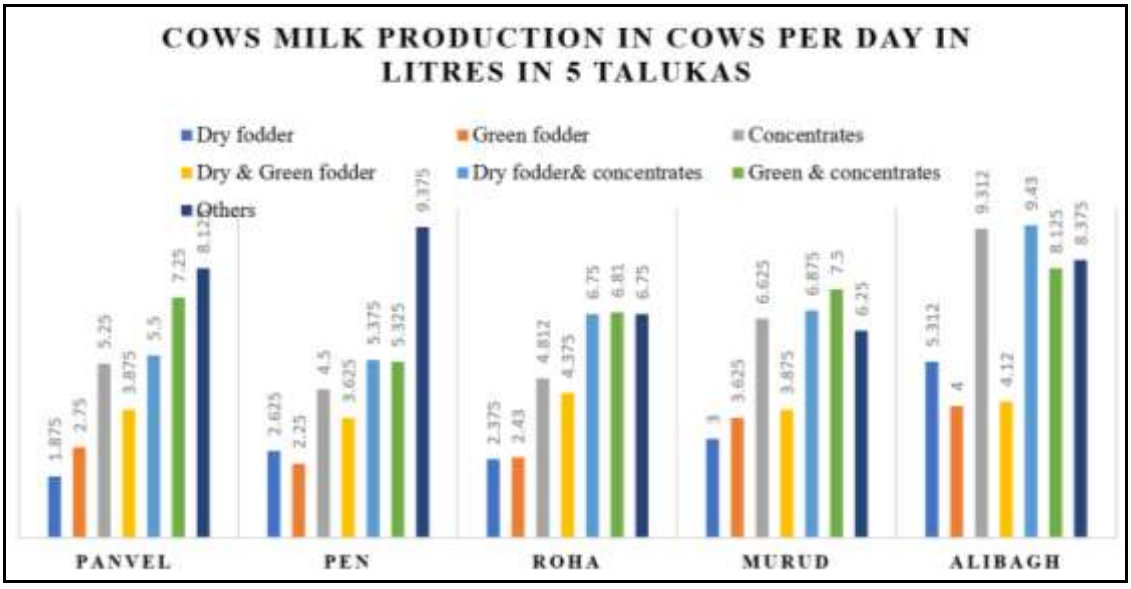

Fig 2: Variation in Milk Production per Cow in Raigad District Based on Different Feeding Regimens

Table 3 shows the daily milk production of cows in Panvel, Pen, Roha, Murud, and Alibagh talukas of Raigad district. The highest milk output was 8.5 for Bovi booster in Panvel, 7.5 for green fodder concentrate, and 2.5 for dry milk in Pen. Roha had averages of 6.81 for green and concentrates, 4.812 for dry and green, 2.43 for green fodder, and 2.375 for dry fodder. Murud had averages of 7.5 for green and concentrates, 6.25 for others, 3.875 for concentrates, 3.625 for green fodder, and 3 for dry fodder. Alibagh had averages of 9.43 for dry and concentrates, 9.312 for dry and green, 8.375 for others, 8.125 for green and concentrates, 5.312 for dry, 4.12 for concentrates, and 4 for green fodder.

Table 4: Outcome of Feed on Milk Production of Buffalos per Day in Litres in Raigad District

Villages	Dry fodder	Green fodder	Dry fodder+ Green fodder	Concentrate	Dry fodder+ Concentrate	Green fodder+ Concentrate	Others (Bovi Boosters)
Outcome of Feed on Milk Production of Buffalo per Day in Litres in Panvel Taluka							
Village 1	3	4	7	6	8	9	10.5
Village 2	2.5	3.5	6.5	6	8.5	9.5	11
Village 3	3	4	7.5	6.5	8	9.5	11
Village 4	3	4	7	6	8.5	9.5	11
Total	11.5	15.5	28	24.5	33	37.5	43.5
Average	2.875	3.875	7	6.125	8.25	9.375	10.8
Outcome of Feed on Milk Production of Buffalo per Day in Litres in Pen Taluka							
Village 1	2	2.5	4.5	3	5	5.5	9.5
Village 2	3	2	5	3.5	6.5	5.5	10.5
Village 3	3.5	2	5.5	4.5	8	10	10
Village 4	2.5	3	5.5	4	6.5	7	11
Total	11	9.5	20.5	15	26	28	41
Average	2.75	2.375	5.125	3.75	6.5	7	10.25
Outcome of Feed on Milk Production of Buffalo per Day in Litres in Roha Taluka							
Village 1	2	3	5	4	6	7	5.5
Village 2	2.5	3.5	6	3.5	6	7	6
Village 3	3	2	5	5	8	7	6.5
Village 4	1.5	3.5	5	4.5	6	8	7.5
Total	9	12	21	17	26	29	25.5
Average	2.25	3	5.25	4.25	6.5	7.25	6.375
Outcome of Feed on Milk Production of Buffalo per Day in Litres in Murud Taluka							
Village 1	2	3.5	5.5	4	6	7.5	6.5
Village 2	1.25	3.5	4.75	3.5	4.75	7	6
Village 3	4	3	7	7.5	11.5	8	5.5
Village 4	6.5	4.5	5.5	11	17.5	7.5	5
Total	13.75	14.5	22.75	26	39.75	30	23
Average	3.43	3.625	5.68	6.5	9.93	7.5	5.75
Outcome of Feed on Milk Production of Buffalo per Day in Litres in Alibaug Taluka							
Village 1	8	3.5	11.5	4.5	12.5	8	8
Village 2	3	5	8	4	7	9	9
Village 3	2.5	4	6.5	3	5.5	7	9
Village 4	4	3	7	4	8	7	9
Total	17.5	15.5	33	15.5	33	31	35
Average	4.375	3.875	8.25	3.875	8.25	7.75	8.75

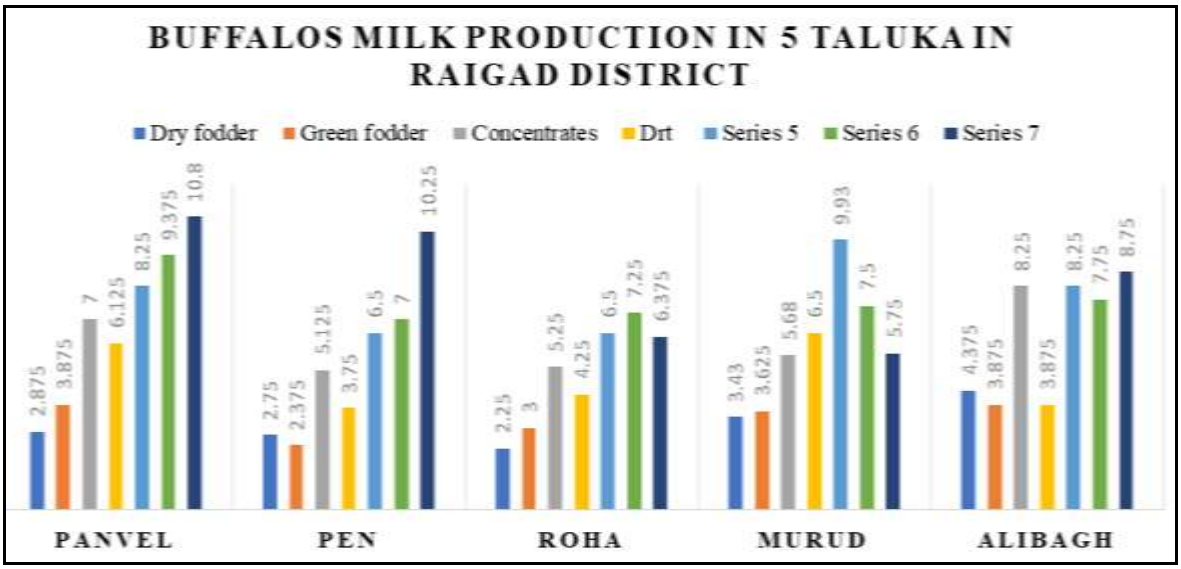

Fig 3: Variation in Milk Production per Buffalos in Raigad District Based on Different Feeding Regimens

Table 4 shows the daily milk production of buffalos in various talukas of Raigad district. In Panvel Taluka, the highest milk yield was achieved when buffalos were fed a combination of green fodder and concentrate. The average milk production for other feeds was 10.8 litres, with concentrates alone yielding 6.125 litres. In Pen Taluka, the average milk production was 10.25 litres for other feeds, higher than 7 litres for green and concentrates. In Roha Taluka, the average milk production was 7.25 litres for green and concentrates, 6.5 litres for dry and concentrates, 6.375 litres for others, 4.25 litres for concentrates, 3 litres for green fodder, and 2.25 litres for dry fodder. In Alibagh Taluka, the average milk production was 8.75 litres for others, 8.25 litres for dry and concentrate, 7.75 litres for green and concentrate, 4.375 litres for dry, and 3.875 litres for concentrate and green fodder.

The data presented in Tables 3 and 4, along with Figures 2 and 3, provides valuable insights into optimizing cattle nutrition to enhance milk production across various talukas of Raigad district. By meticulously analyzing the milk yield figures associated with different feed combinations involving dry fodder, green fodder, concentrates, and supplements like Bovi booster, dairy farmers can make informed decisions to maximize the productivity of their buffalo herds. This information serves as a crucial reference for devising tailored feeding strategies that address the specific nutritional requirements of cattle in each taluka, ultimately contributing to the overall growth and sustainability of the region`s dairy industry. In this context, a study on the dynamics of the cattle feed market and its marketing in Raigad district, Maharashtra, was conducted during 2023-24. The study aimed to assess the demand patterns, general market trends, and growth prospects of animal feed. The market for compound animal feed is estimated to be around 5.5 million tonnes [13]. Private agencies produce approximately 1.2 million tonnes, while the dairy cooperative and government sectors produce around 2.5 million tonnes, which are sold to milk producers at subsidized prices. The remaining feed is produced by farmers themselves as home mixers. Additionally, the study examined cattle feed manufacturing companies supplying their products in pellet and mash forms, among other types. Of the total feed market, 56.5% consists of pellet-type feed, with Occamy Bioscience holding the highest percentage at 17.5%. For mash-type feed, six companies contribute 28.5%, while other types account for the remaining 15%. The findings regarding the consumption of pellet-type feed followed by mash-type and other types are consistent with research conducted in Kerala [15]. This comprehensive analysis of feed demand and market dynamics in Raigad district highlights the importance of understanding local feed preferences and production capabilities. By aligning feed strategies with these insights, dairy farmers can enhance milk yield and support the sustainable growth of the dairy industry in the region.

Conclusion

The livestock sector in Maharashtra, particularly in Raigad district, is crucial for the rural economy, providing income, employment, nutrition, and manure supply. The evolving cattle feed industry, dominated by pellet and mash feed, is approaching maturity, with 56.5% of the market dominated by pellet-type feed. Feed and fodder contribute up to 50% of livestock productivity and production. However, milk production costs vary widely, with crossbred cows and buffaloes yielding positive returns and local cows incurring higher costs. New technologies like silage making and urea treatment can mitigate these costs and enhance efficiency, healthcare, breeding facilities, and dairy management. Understanding feed demand, supply dynamics, and the impact of feed types on milk production can help dairy farmers optimize cattle nutrition, maximizing milk yields and supporting sustainable growth in Raigad district and Maharashtra.

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