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ORIGINAL

Factors Affecting Quality Milk Productivity in Dairy Farming

Factores que afectan a la productividad de la leche de calidad en las producciones lecheras

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ABSTRACT

This study examines the current state of dairy farming in India. It investigates the impact of four factors (cattle feed, cattle health, climatic conditions, and milk handling) on milk productivity from the perspective of dairy farmers. A cross-sectional study using inferential statistics was conducted with dairy farmers, using a questionnaire to gather information on milk productivity. The study employed SmartPLS to analyze the measurement and structural models to support the positive hypothesis. The study employed a combinative PLS method, which aligns with the characteristics of a structural equation model. A focused group analysis was also performed to gather respondents' opinions and provide recommendations. The findings indicate a positive relationship between the four independent variables and milk productivity quality. Furthermore, adopting an organic and natural approach to cattle feed can reduce feed costs. Access to government veterinary hospitals, along with continuous medical support and potential private veterinary hospitals, as well as the use of proper concrete, sheds with effective heat management and measures to address rainy season challenges, and maintaining hygiene during milk transportation, will be beneficial for dairy farmers and lead to increased milk productivity.

Keywords: Quality Milk Productivity; Cattle Feed; Cattle Health; Climatic Condition; Milk Handling.

RESUMEN

Este estudio examina el estado actual de la ganadería lechera en la India. Investiga el impacto de cuatro factores (alimentación del ganado, salud del ganado, condiciones climáticas y manipulación de la leche) en la productividad lechera desde la perspectiva de los ganaderos. Se realizó un estudio transversal con estadísticos inferenciales entre ganaderos lecheros, utilizando un cuestionario para recabar información sobre la productividad de la leche. El estudio empleó SmartPLS para analizar los modelos de medición y estructurales a fin de respaldar la hipótesis positiva. El estudio empleó un método PLS combinativo, que se ajusta a las características de un modelo de ecuaciones estructurales. También se realizó un análisis de grupo específico para recabar las opiniones de los encuestados y

ofrecer recomendaciones. Los resultados indican una relación positiva entre las cuatro variables independientes y la calidad de la productividad lechera. Además, la adopción de un enfoque orgánico y natural en la alimentación del ganado puede reducir los costes de los piensos. El acceso a hospitales veterinarios públicos, junto con un apoyo médico continuo y posibles hospitales veterinarios privados, así como el uso de hormigón adecuado, cobertizos con una gestión eficaz del calor y medidas para hacer frente a los problemas de la temporada de lluvias, y el mantenimiento de la higiene durante el transporte de la leche, serán beneficiosos para los productores de leche y conducirán a un aumento de la productividad lechera.

Palabras clave: Productividad de la Leche de Calidad; Alimentación del Ganado; Salud del Ganado; Condiciones Climáticas; Manejo de la Leche.

INTRODUCTION

Milk has been a staple in our diets for centuries, offering a rich source of essential nutrients necessary for human life (Astrup et al., 2015). Packed with vitamin C, protein, saturated fat, and calcium, milk is crucial in maintaining the health of growing children, pregnant women, and patients (Visioli & Strata, 2014). Beyond its nutritional benefits, milk has become a top priority in the health and business sectors (Shahbandeh, 2020). Milk has gained significance in flavor, healthfulness, appearance, and suitability with a wide range of milk products, such as cheese, cream, yogurt, butter, and ghee (FAO, 2020). The global demand for milk has seen continuous and robust growth, with an annual consumption of approximately 852 million tons worldwide (ITC, 2020). Milk production has increased by over 60 % in the past three decades, driven by countries like India, the USA, Pakistan, Brazil, China, Russia, Germany, France, New Zealand, and Turkey (FAO, 2020). Import and export of milk have also played a significant role in meeting global demand, with New Zealand leading in exports and China leading in imports (IBEF, 2020).

India is the largest country globally, contributing 22 % of global milk production annually (Reddy & Padmavathi, 2016). The Indian agricultural economy heavily relies on milk production, supporting rural development and providing livelihoods for millions of small-scale farmers (Mayberry et al., 2017). However, there is a constant need to improve milk production in India to meet the demands of a growing population, future requirements, and global opportunities (Sankar & Yoganandham, 2016). Within India, Tamil Nadu ranks among the top ten states in milk production, which is crucial in reducing poverty and promoting rural welfare (Douphrate et al., 2013; Umamageswari et al., 2017). The state's milk co-operatives have been instrumental in creating a robust network for milk markets, providing technical support and health services to the rural population (Pandian et al., 2013; Sankar, 2016a). Vellore, a significant district in Tamil Nadu, has emerged as a key player in milk production, boasting the largest milk procurement and the third-largest milk chilling capacity in the state (GoTN, 2020; Reporter, 2016).

To ensure the sustainability and quality of milk productivity, it is essential to identify the factors that affect its production (Bernet et al., 2001; Sankar, 2016b). Cattle feed (Prasad et al., 2019), cattle health (Mullan et al., 2020), climatic conditions (Kant et al., 2017), and milk handling (Ahmed et al., 2020) have been recognized as key variables influencing the quality of milk productivity. However, there is limited research specifically focused on these factors in the Vellore district of Tamil Nadu, India. This study aims to address this research gap by investigating the relationship between cattle feed, cattle health, climatic conditions, milk handling, and the quality of milk productivity among producers in the Vellore district. By analyzing these factors, the study aims to provide valuable insights to decision-makers, policy-makers, and milk producers, enabling them to plan and enhance milk productivity effectively. Through a

comprehensive review of existing literature and utilizing various quality indicators of milk productivity (Prasad et al., 2019; Mullan et al., 2020; Kant et al., 2017; Ahmed et al., 2020), this study aims to shed light on the variables that contribute to the quality of dairy farming. The results of this research will benefit local milk producers, provide a valuable perspective for future studies, and contribute to the overall improvement of the dairy industry.

Literature review and hypothesis development

Cattle feed and the quality milk productivity

Agricultural by-products such as straw, wheat, weeds, and sugar cane tops are important sources of cattle feed (Reddy et al., 2018). In addition to these by-products, cattle feed can consist of grass-fed, corn-fed, and other supplementary feeds (Reddy et al., 2018). Cattle feed serves not only as a part of the daily food routine for cattle but also plays a role in their health and milk productivity (Connor, 2015). Previous observations have indicated that in dairy farming, cows that are provided with supplemental cattle feed through grazing behavior tend to exhibit increased milk production (Merino et al., 2019). The cattle feeding rate is a crucial factor affecting the quality of milk productivity. Due to the influence of feed cost on the feeding rate, dairy farming often employs low-cost cattle feed to reduce expenses (Erickson & Kalscheur, 2020). Implementing feeding strategies in dairy farming that involve supplements can increase milk fat content and productivity (Auldist et al., 2016). This benefits small-scale dairy farming, improving milk productivity and performance (Wanapat et al., 2018).

Numerous studies have explored the relationship between milk productivity and cattle feed quality, with findings suggesting that increased consumption of high-sugar grass and dry matter leads to higher milk yields (Moorby et al., 2006). Martono et al. (2016) found that including cattle feed resulted in a significant increase of 20,88 % in milk productivity. Moreover, supplementing cattle feed has been shown to enhance dairy cattle's efficiency and improve milk productivity by promoting better digestion and nutrient absorption (Susanti et al., 2007). Increasing the quantity of livestock feed leads to sustainable milk productivity and brings social and economic benefits (Okano, 2017). In small-scale dairy farming, the availability of adequate cattle feed is closely associated with increased milk productivity and serves as a means to reduce rural poverty (Pereira et al., 2020; Suzuki & Pfeiffer, 2009). A study on Nellore cattle in dairy farming highlighted the positive effect of healthy cattle feed on feeding behavior and milk productivity. Accordingly, it is hypothesized that:

H1. There is a relationship between the cattle feed and the quality milk productivity in dairy farming

Cattle health and the quality milk productivity

Cattle health and cattle feed are interconnected, as excellent and nutritious cattle feed plays a crucial role in maintaining dairy cattle's excellent health and quality milk productivity. Numerous studies have shown that enhancing milk yields in herds can be achieved through improved nutrition and cattle health (Connor et al., 2012). The quality of cattle fodder, feed, value chain, and distribution are all linked to cattle health. Cattle health significantly influences the cost of milk production (Sankar & Yoganandham, 2021). In India, the availability of cheap labor has resulted in a significant reduction in production costs and an increase in the quality of milk productivity (Patel, 2016). Ensuring cattle health is vital for enhancing the quality of milk productivity. However, adulteration in cattle feed is risky and can harm cattle health. Hazardous substances such as white paint, detergents, refined oil, and caustic soda threaten cattle health (Joshi, 2015). The cost efficiency of cattle health is a determining factor in improving the quality of milk productivity and generating returns on dairy investments (Feroze et al., 2016).

The price increase of cattle feed items like straw, dried hay, and cereals impact cattle health and nutrition. Challenges such as ticks also pose a major threat to maintaining cattle health. Controlling and eliminating tick infections can be costly and affect milk productivity (Jain et al., 2020). The study by

Keshavarzi et al. (2020) highlights the association between cattle health and the quality of milk productivity. However, milk productivity can decrease due to cattle health issues related to new lactation abortion and rebreeding abortion. Effective cattle health management leads to reduced medical expenses and economical treatment. Good cattle monitoring enhances the quality of milk productivity (Egger-Danner et al., 2020). Continuous medical assessment plays a crucial role in supporting cattle health, reducing mortality and diseases, and overall improving the quality of milk productivity (Sharma et al., 2019). Therefore, it is hypothesized that:

H2. There is a relationship between cattle health and the quality milk productivity in dairy farming

Climatic conditions and the quality milk productivity

The suitability of certain high milk-yielding cattle breeds in India is affected by the country's climatic conditions, and climate changes can also impact the quality of milk production due to associated diseases (Landes et al., 2017). Despite India having the largest dairy herd globally, factors such as geography, size, and climate influence the quality of milk production compared to dairy farming in developed countries (Feroze et al., 2019). Nevertheless, certain cattle breeds can adapt to India's climatic conditions, enhancing milk production quality (NDRI, 2016). Dairy farmers need to consider the size of their farms and the prevailing climatic conditions when designing appropriate shelters, as this can contribute to increased milk productivity (Janssen et al., 2019). Research conducted by Ouellet et al. (2019) has shown a direct correlation between climatic conditions and milk productivity, indicating that higher temperatures can lead to reduced milk protein, fat, and volume, ultimately resulting in lower-quality milk production.

Greenhouse gas emissions play a significant role in dairy farming, and the design of cattle shelters is closely connected to the prevailing climatic conditions. Implementing environmentally friendly cattle shelters can address climatic challenges and increase milk productivity (Samal & Pattanaik, 2014). According to Harrisong et al. (2017), long-term strategic planning can help mitigate the impacts of short-term climatic changes. Additionally, climate change can increase the cost of cattle feed, reduce milk productivity, and impact farmers' income, particularly in low-income developing countries where small-scale dairy farmers may experience months of low milk production due to climatic changes (Tricarico et al., 2020). Unstable seasonal fluctuations significantly influence the quality of milk production, milk procurement, and milk marketing for dairy farmers (Singh & Srivastava, 2019). A comprehensive study conducted by Cardoso et al. (2016) emphasizes the close relationship between climatic conditions, environment, and cleanliness in cattle health and the quality of milk production. Accordingly, it is hypothesized that:

H3. There is a relationship between the climatic condition and the quality milk productivity in dairy farming.

Milk handling and the quality milk productivity

Proper handling is essential to convert increased milk productivity into revenue. The process involves clean and hygienic milking, whether done manually or using machines, followed by milk storage, processing, and distribution (Kunte & Patankar, 2015). Implementing strategies such as automatic milking systems can help dairy farmers improve milk handling and enhance the quality of milk productivity (Stephansen et al., 2018). A study conducted by Amenu et al. (2020) demonstrated that long-term practices such as adopting technology, improving environmental conditions, and ensuring sanitation could extend the shelf life of milk and enhance its quality, thereby increasing milk productivity. The quality and safety of milk and other dairy products depend on a series of activities, including cattle health, milk testing, and clean-in-place strategies to ensure milk safety. Science-based strategies are crucial, such as protecting milk from spoilage during collection, transportation to processing plants, clarification, homogenization, pasteurization, and appropriate packaging (Boor et al., 2017).

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In their comprehensive study, Vries et al. (2020) highlighted the challenges small dairy farming operations face, such as insufficient cattle feed, poor cattle health, and unfavorable climatic conditions. Effective milk handling, including production and safety measures, can significantly improve the quality of milk productivity (Mogotu et al., 2022). Automatic milking systems are particularly beneficial for farms requiring frequent milking, contributing to sustainability, storage stability, structural integrity, and milk taste. These systems also support the milk industry in maintaining milk quality during processing (Hogenboom et al., 2019). Milk handling plays a critical role in preserving the nutritional value of milk. Additional measures, such as boiling milk before consumption, can be implemented to overcome processing-related challenges like chilling (Owusu-Kwarteng et al., 2020). Automated milking, processing systems, and proper milk handling enhance milk quality (Rao, 2016). Therefore, it is hypothesized that:

H4. There is a relationship between milk handling and the quality milk productivity in dairy farming

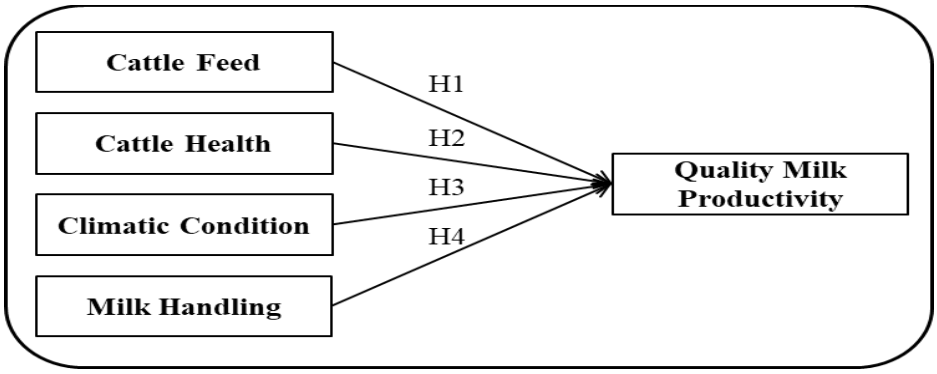

Figure 1. Research Model

Figure 1 illustrates a research model encompassing four independent variables: cattle feed, cattle health, climatic conditions, and milk handling. These variables are examined about the dependent variable, the quality of milk productivity. The framework was constructed by incorporating insights from diverse sources, including published and unpublished research data, reputable journals with high indices, practical expertise, and multiple definitions of milk productivity.

METHODS

The study was conducted among dairy farmers in the Katpadi Panchayat Union (Block), Vellore District of Tamil Nadu, India. The Katpadi Panchayat Union (Block) consists of 21 village panchayats, namely Vanjur, Vandranthangal, Thandalam Krishnpuram, Sevur, Serkadu, Senur, Sembarayanallore, Puthur, Mettukulam, Kuppathamottur, Kugaiyanallore, Karnampattu, Karigiri, Karasamangalam, Kandipedu, Jaffrapet, Eranthangal, Brahmapuram, Arumparuthi, Arimuthumothur, and Ammundi. The study employed a two-level approach involving a questionnaire and discussions.

At level 1, a self-made questionnaire was used, consisting of two parts. The first part included closed-end questions using a 5-point Likert scale (5 - strongly agree, 4 - agree, 3 - neutral, 2 - disagree, 1 - strongly disagree). This part focused on four variables: cattle feed (Prasad et al., 2019), cattle health (Mullan et al., 2020), climatic conditions (Kant et al., 2017), and milk handling (Ahmed et al., 2020). Each variable had three questions associated with it. The second part of the questionnaire involved an open discussion to gather respondents' opinions on the quality of milk productivity based on cattle feed, cattle health, climatic conditions, and milk handling. No missing data were encountered as the data collection occurred through focused group discussions.

The focused group comprised one group from each of the 21 village panchayats, comprising six members. Based on the researcher's classification, the six members were categorized into two small

dairy farmers, two medium dairy farmers, and two large dairy farmers. Small dairy farmers had up to 5 cattle, medium dairy farmers had 6-20 cattle, and large dairy farmers had more than 20 cattle (Shahjahan, 2017). One hundred twenty-six dairy farmers participated in the study, with six respondents in each of the 21 groups.

The researcher translated the questions into the regional language (Tamil) for the respondents to facilitate better understanding and convenience. In the first level of analysis, the closed-end questionnaires were evaluated for model fit, composite reliability, discriminant validity, and Heterotrait-Monotrait Ratio of Correlations. The validity and reliability of the instrument were assessed using Synergetic PLS. SmartPLS 3.3.2 was used to analyze the measurement and structural models to test the positive hypothesis influence of constructs. Therefore, the study employed a combinative PLS method that met the requirements of a structural equation model. At the second level, the respondents were requested to provide their opinions on cattle feed, cattle health, climatic conditions, and milk handling, focusing on the quality of milk productivity. They were encouraged to elaborate on their opinions and provide examples if possible.

RESULTS

Goodness of model fit

The evaluation process involved measuring the suitability of the model fit, which is necessary to assess the model before analyzing the measurement and structure model (Henseler et al., 2016). Additionally, analyzing the model using fit indices or inference statistics is mandatory. The evaluation of model fit should be done through the model fit test of the approximate model fit (Dijkstra & Henseler, 2015).

Table 1. Goodness of model fit

Fit criteria	Value
SRMR	0,085
d_{ULS}	0,974
d_G	0,468

The data presented in table 1 demonstrates the appropriate measure of model fit using the standardized root mean square residual (SRMR) (Dijkstra & Henseler, 2015). According to conventional standards, an SRMR value below 0,1 is considered acceptable, and in this case, the calculated value of 0,085 indicates a good fit for SRMR. Additionally, other model fit criteria are employed using the PLS Algorithm bootstrap to verify the unweighted least squares discrepancy (dULS) and geodesic discrepancy (dG) (Hair et al., 2017). A conservative viewpoint suggests that dG and dULS values below the 95th percentile of the bootstrap quantile are desirable. In this study, the computed values of 0,468 and 0,974 meet these criteria, indicating a good fit for the model.

Table 2. Indicator reliability, internal consistency, convergent validity, and fornell-larcker test of discriminant validity

	Alpha	CR	AVE	CAF	CAH	CLC	MLH	QMP
CAF	0,773	0,868	0,688	0,829				
CAH	0,786	0,827	0,617	0,678	0,785			
CLC	0,789	0,877	0,703	0,628	0,729	0,839		
MLH	0,767	0,821	0,604	0,641	0,636	0,550	0,777	
QMP	0,821	0,881	0,651	0,772	0,723	0,723	0,728	0,807

Several criteria were considered to assess the reliability of the measurement scale systematically. Hair et al. (2017) state that Cronbach's alpha, composite, and consistency reliability values should exceed 0,70. Upon examining table 2, it was evident that these values surpassed the threshold, indicating that

the measurement scale was suitable for evaluation. Additionally, the average variance extracted (AVE) representing convergent validity should exceed 0,50, per Hair et al. (2017). The data presented in table 2 demonstrated that the AVE values were higher than the minimum requirement, affirming that the questionnaire accurately reflected the model's characteristics and each research variable. Further, the Fornell-Larcker criterion (Fornell & Larcker, 1981) was commonly employed to evaluate the degree of shared variance within the model. In Table 2, the calculated values were below 0,9, confirming discriminant validity. In conclusion, the results conclusively established the reliability and validity of the measurement scales.

Table 3. HTMT results

	CAF	CAH	CLC	MLH	QMP
CAF					
CAH	0,834				
CLC	0,803	0,886			
MLH	0,869	0,825	0,727		
QMP	0,870	0,896	0,893	0,853	

The Heterotrait-Monotrait Ratio of Correlations (HTMT) criterion was systematically employed to assess discriminant validity. According to Henseler et al. (2014), if the HTMT values are below 0,90, there is discriminant validity between the two reflective constructs. Based on the results presented in Table 3, where the values were below 0,90, it can be concluded that the measurement scales used in this study are reliable and valid.

Structural equation modeling (SEM)

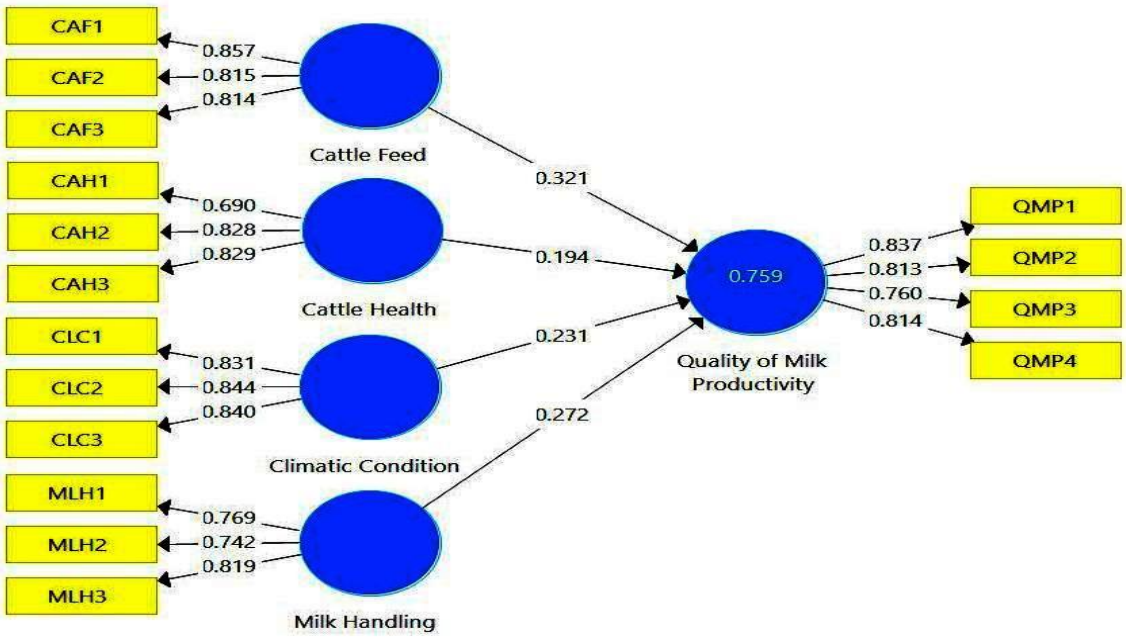

Figure 2. Structural equation modeling PLS result

Figure 2 illustrates that the estimated equation has an R2 value of 0,759. This indicates that 75,9 percent of the variability in milk productivity can be attributed to factors such as cattle feed, cattle health, climatic conditions, and milk handling.

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Table 4. Structural hypothesis

	Beta	SE	P-Values	VIF
Cattle Feed → Quality of Milk Productivity	0,321	0,081	0,000	2,255
Cattle Health → Quality of Milk Productivity	0,194	0,091	0,034	2,784
Climatic Condition → Quality of Milk Productivity	0,231	0,094	0,014	2,307
Milk Handling → Quality of Milk Productivity	0,272	0,093	0,004	1,957

Table 4 clearly illustrates the results obtained using the structural relationship PLS Algorithm. The Tolerance and Variance Inflation Factors (VIF) were calculated to assess multicollinearity. Multicollinearity issues are indicated by VIF values exceeding 4,0 or tolerance values below 0,2 (Hair et al., 2017). In this study, the Collinearity Statistics (inner VIF values) for cattle feed, cattle health, climatic conditions, and milk handling were 2 255, 2 784, 2 307, and 1 957, respectively. These values were all below four, indicating the absence of multicollinearity effects among the variables.

Table 5. Hypothesis testing

	Beta	t-Statistics	P-Values	Decision
Cattle Feed → Quality of Milk Productivity	0,321	3,952	0,000	Supported
Cattle Health → Quality of Milk Productivity	0,194	2,128	0,034	Supported
Climatic Condition → Quality of Milk Productivity	0,231	2,466	0,014	Supported
Milk Handling → Quality of Milk Productivity	0,272	2,920	0,004	Supported

Table 5 presents compelling evidence supporting the hypothesis through the utilization of bootstrapping. The analytical bootstrapping technique was employed to assess the significance of the path between variables, using 5000 re-sampling methods via SmartPLS. The results indicate a positive relationship between cattle feed and the quality of milk productivity (β=0,321, p<0,05), thereby accepting H1. Similarly, the findings demonstrate a positive relationship between cattle health and milk quality (β=0,194, p<0,05), confirming H2. Moreover, the results reveal a positive association between climatic conditions and milk quality (β=0,231, p<0,05), validating H3. Additionally, the data indicate a positive correlation between milk handling and milk quality (β=0,272, p<0,05), accepting H4. To enhance milk productivity, combining cattle feed with early diagnosis and maintenance of cattle health (Butler et al., 2011). The production system, influenced by climatic conditions, significantly affects milk handling and consequently impacts milk quality (Marcondes et al., 2014).

Focused group analysis

The focused group is composed of 21 village panchayats, with each panchayat representing one group. Each group comprises six members: two small dairy farmers, two medium dairy farmers, and two large dairy farmers. These 21 village panchayats are referred to as cohorts C1 to C21. The researcher categorized the respondents based on their number of cattle: those with up to five cattle were classified as small dairy farmers (S1 and S2), those with 6-20 cattle were categorized as medium dairy farmers (M1 and M2), and those with more than 20 cattle were classified as large dairy farmers (L1 and L2).

Cattle feed

According to the respondents' group (Resp.7 C2 S1), the different feed varieties significantly impact milk yield in dairy farms. The ideal feed in dairy farms is grass, as stated by the respondents (Resp.27 C5 M1). It is recommended that all dairy farms use grass as an essential feed for cattle (Resp.47 C8 L1). The respondents suggest that cattle feed should be grass-based and organic, discouraging the use of chemicals and hormones in dairy farms (Resp.57 C10 M1). To increase milk production, dairy farms must provide more natural feed and allow for open grazing, as indicated by the respondents (Resp.78 C13 L2). The cost of cattle feed includes labor utilization, as mentioned by the respondents (Resp.92 C15 S2).

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According to the respondents, cattle feed and fodders play a crucial role in the total cost of a dairy farm (Resp.99 C17 M1). The respondents state that improving cattle feed and fodder can enhance milk productivity and the overall health of the cattle (Resp.114 C19 L2). The cost of cattle feed includes labor expenses for grass cutting, and the respondents suggest that improving cattle feed can lead to increased milk productivity (Resp.117 C20 M1). Cattle feed directly impacts the quality and quantity of milk productivity, as highlighted by the respondents (Resp.122 C21 S2).

Cattle health

The respondents' group expressed their thoughts on cattle health in dairy farms, emphasizing the importance of disease-free and well-maintained cattle with proper veterinary care (Resp.4 C1 M2). Maintaining cleanliness in cattle shelters and creating a clean environment contributes to the overall health of the cattle (Resp.13 C3 S1). The health of the cattle is closely connected to the well-being of the individuals responsible for their care (Resp.24 C4 L2). An effective feeding strategy for better cattle health can increase milk productivity (Resp.33 C6 M1). Various practices, such as cattle health care and disease management, can enhance milk productivity (Resp.38 C7 S2). Delayed access to veterinary doctors and lack of timely treatment can negatively impact cattle health (Resp.53 C9 L1). The absence of private veterinary hospitals in the study area, with only government veterinary dispensaries available, poses challenges in maintaining cattle health (Resp.72 C12 L2). Veterinary dispensaries with qualified doctors can help reduce abortion rates and prevent cattle deaths during childbirth (Resp.91 C16 S1). Cattle health increases milk productivity and ensures quality (Resp.82 C14 M2). Optimal cattle health is essential for running a profitable dairy farm and supplying high-quality milk to the dairy industry (Resp.107 C18 L1).

Climatic condition

The study participants discussed the climatic conditions in dairy farms (Resp.118 C20 M2). The study area experiences extreme weather conditions, with intense heat during summer and severe cold during winter. These conditions significantly challenge maintaining milk productivity (Resp.118 C20 M2). Except for the four summer months, milk production and the climate are highly favorable and profitable during other seasons (Resp.97 C17 S1). Fluctuations in the weather directly impact the milk production of small-scale dairy farmers (Resp.85 C15 S1). Besides summer, the climatic conditions are conducive to milk productivity, living conditions, and overall well-being (Resp.71 C12 L1). During the summer, permanent and temporary shelters, such as pucca sheds and kutcha sheds, mitigate the effects of the scorching climate (Resp.58 C10 M2). Concrete sheds are ideal for the rainy season as they facilitate cleaning and hygiene maintenance (Resp.54 C9 L2). Both cattle breeds and dairy farmers must adapt to the changing climate to ensure a safe environment (Resp.37 C7 S1). Proper management of the climatic conditions benefits cattle, dairy farmers, and the surrounding community (Resp.28 C5 M2). Effective management of weather conditions helps reduce odor and diseases spread by mosquitoes (Resp.14 C3 S2). Creating a clean environment with minimal chemical usage promotes high-quality milk production through eco-friendly practices (Resp.11 C2 L1).

Milk handling

The respondents highlighted Several key points regarding milk handling in dairy farms. The proper handling of milk is crucial for maintaining its freshness over an extended period and ensuring the quality of milk products (Resp.124 C21 M2). Utilizing the natural milking method is superior to employing injections, as it helps preserve the milk's freshness and ensures its suitability for further handling (Resp.109 C19 S1). Cleaning the milking machine involves several steps, including cold water rinse, detergent application, hot water rinse with dairy detergent, and another hot water rinse. This thorough cleaning procedure is time-consuming, but cleaning the machine properly can harm milk quality (Resp.48

C8 L2). Although the severity of chemicals used during milk processing may be reduced, it is important to note that such milk is not suitable for direct consumption (Resp.108 C18 L2). Maintaining cleanliness and hygiene while milking, including properly cleaning cloths, vessels, storage cans, and hands, can help minimize milk spoilage and extend its shelf life (Resp.92 C16 S2). The proximity between milk processing units and dairy farms plays a vital role in ensuring milk quality, as shorter distances contribute to keeping the milk fresh and minimizing spoilage (Resp.83 C14 L1). The process of milk handling involves collecting milk from various small milk points and transporting it to the agent before reaching the milk processing unit. This time-consuming process negatively impacts milk quality (Resp.75 C13 M1). Adulteration incidents occur during transportation, leading to a decrease in milk quality and lower prices for the milk (Resp.62 C11 S2). The duration of milk processing significantly affects its quality, as a lengthy process can result in milk spoilage and financial losses for dairy farmers (Resp.36 C6 L2). Incorrect milk fat calculations can reduce milk prices and financial losses for dairy farmers (Resp.21 C4 M1). Any mishandling or errors at the chilling point or processing plant can diminish the overall quality and productivity of the milk (Resp.5 C1 L1).

DISCUSSION

The study's results indicate that hypothesis H1 is supported, as there is a positive relationship between cattle feed and the quality of milk productivity at a significance level of 1 % (3,747). Providing cattle with a proper feed diet improves milk productivity and contributes to community health. Cattle feed positively impacts dairy farms' productivity, sustainability, and profitability (Vandehaar et al., 2006). Similarly, H2 is supported, as there is a positive relationship between cattle health and the quality of milk productivity at a significance level of 10 % (1,533). Cattle health plays a crucial role in enhancing milk productivity, reducing disease transmission, ensuring the safety of dairy products, and benefiting the economies of middle and low-income countries (Garcia et al., 2019).

Furthermore, H3 is supported, as there is a positive correlation between climatic conditions and the quality of milk productivity at a significance level of 5 % (2,132). The primary factors influencing milk productivity are climatic conditions, particularly high temperatures, and rainfall. Constant monitoring and effective milking management practices are essential for maximizing profits in dairy farms (Picinin et al., 2019). Additionally, H4 is supported, as there is a positive relationship between milk handling and the quality of milk productivity at a significance level of 5 % (2,132). Proper milk handling practices and management methods significantly contribute to improving milk productivity. It is crucial to raise awareness among dairy farmers about adequate milk handling techniques to increase production and profitability (Mitiku et al., 2019).

The focused discussion highlights the advantages of cattle feed, cattle health, climatic conditions, and milk handling in enhancing the quality of milk productivity. It also sheds light on dairy farmers' challenges and expectations for increasing milk productivity. The respondents emphasized that cattle feed and fodder are crucial in increasing milk production, but the associated costs must be considered. The respondents also stressed that maintaining cattle health, cleanliness, and disease control are essential for maximizing milk production. They highlighted the challenges of middle- and low-income countries in ensuring cattle health and nutrition (Martin, 2015).

Furthermore, respondents emphasized the importance of favorable climatic conditions and proper cattle shed management to optimize milk productivity and mitigate the negative impact of heat stress (Lambertz et al., 2014). Milk handling was another important factor highlighted by the respondents, emphasizing the need for hygiene and efficient transportation between the farm and the milk processing unit. They suggested that awareness and training in transportation, storage, and hygiene practices are crucial for improving milk productivity (Thanh et al., 2015). Based on the dairy farmers' perspectives, the study provides suggestions to decision-makers for enhancing the quality of milk productivity. It recommends implementing different support systems tailored to the needs of dairy farmers at different

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levels. Promoting organic and natural cattle feed and fodder can increase milk productivity while reducing costs. Establishing government veterinary hospitals and providing continuous medical support, along with private veterinary hospitals, will support dairy farms in improving milk productivity. Constructing durable and well-designed cattle sheds with proper heat management and measures to address rainy season difficulties will further enhance milk productivity.

Additionally, prioritizing hygiene and implementing efficient milk transportation practices will prove profitable for dairy farmers and increase milk productivity (Teresiah et al., 2016). The study offers decision-makers a systematic set of recommendations for improving milk productivity, taking into account the perspectives of dairy farmers. Implementing various support systems tailored to the different levels of dairy farmers can significantly enhance the quality of milk production. Employing organic and natural methods for cattle feed and fodder can increase milk productivity and reduce the cost of feed. Additionally, the provision of government veterinary hospitals and ongoing medical assistance, including potential private veterinary hospitals, will contribute to the overall milk productivity of dairy farms. Furthermore, constructing well-designed concrete sheds with effective heat management and measures to overcome challenges during the rainy season will further boost milk productivity. Ensuring proper hygiene and efficient milk transportation practices will not only prove profitable for dairy farmers but also lead to increased milk productivity.

CONCLUSION

Established procedures systematically organized the findings of this study to ensure validity and reliability. The research utilized Structural Equation Modelling to demonstrate a positive relationship between milk productivity quality and four key factors: cattle feed, cattle health, climatic conditions, and milk handling, as dairy farmers perceive. A focused group analysis was conducted to gather respondents' perspectives and provide recommendations. The results indicate that all four factors are significant, with cattle feed exhibiting strong associations and emphasizing milk productivity's importance. The findings also highlight the need for improvements in cattle health to enhance milk quality and adjustments in climatic conditions and milk handling practices to support milk productivity.

Furthermore, policy-makers, administrators, and the government are responsible for implementing these procedures, which play a crucial role in enhancing milk productivity. By incorporating various findings obtained through different methodologies and insights from respondents through focused group analysis, this study enriches our understanding of milk productivity quality from the viewpoint of dairy farmers. The research identifies the necessity for cost management in cattle feed, the establishment of comprehensive veterinary dispensaries with private sector involvement for cattle health, the provision of proper shelter to address climatic conditions, and the implementation of efficient logistics and processing methods for milk handling, all of which contribute to enhancing milk productivity.

Limitations and future research

This study focuses on the Katpadi Panchayat Union (Block) dairy farmers in Vellore District, Tamil Nadu, India. In subsequent studies, it would be beneficial to incorporate additional factors, such as moderation or mediation effects, into the framework. This current study is a foundation for future research to explore milk productivity and quality in other regions with diverse participants. New variables may be introduced, or existing variables may be excluded from the research framework. Additionally, conducting the study with cross-cultural respondents could provide insights into potential variations in the results. Furthermore, modifications in qualitative and quantitative techniques can be implemented to enhance the research process.

REFERENCES

1. Ahmed, I., Kumar, S., & Aggarwal, D. (2020). Assessment of knowledge and practices of hygienic

milk production among dairy farmworkers, Southwest Delhi. Indian Journal of Community Medicine, 45(1), 26–30. https://doi.org/10.4103/ijcm.IJCM_366_19

2. Amenu, K., Agga, G. E., Kumbe, A., Shibiru, A., Dego, K. O., Wieland, B., Grace, D., Alonso, S., Desta, H., & Tik, W. (2020). Community-tailored training to improve the knowledge, attitudes, and practices of women regarding hygienic milk production and handling in Borana pastoral area of southern Ethiopia. Journal of Dairy Science, 103(11), 9748–9757.

3. Astrup, A., Raben, A., & Geiker, N. (2015). The role of higher protein diets in weight control and obesity-related comorbidities. International Journal of Obesity, 39(5), 721–736. https://doi.org/10.1038/ijo.2014.216

4. Auldist, M. J., Marett, L. C., Greenwood, J. S., Wright, M. M., Hannah, M., Jacobs, J. L., & Wales, W. J. (2016). Milk production responses to different strategies for feeding supplements to grazing dairy cows. Journal of Dairy Science, 99(1), 657–671. https://doi.org/10.3168/jds.2015-9834

5. Bernet, T., Staal, S., & Walker, T. (2001). Changing Milk Production Trends in Peru. Mountain Research and Development, 34(1), 268–275. https://doi.org/10.1659/0276-4741(2001)021[0268:cmptip]2.0.co;2

6. Boor, K. J., Wiedmann, M., Murphy, S., & Alcaine, S. (2017). A 100-Year Review: Microbiology and safety of milk handling. Journal of Dairy Science, 100(12), 9933–9951. https://doi.org/10.3168/jds.2017-12969

7. Butler, G., Nielsen, J. H., Larsen, M. K., Rehberger, B., Stergiadis, S., Canever, A., & Leifert, C. (2011). The effects of dairy management and processing on quality characteristics of milk and dairy products. NJAS - Wageningen Journal of Life Sciences, 4(9), 782–786. https://doi.org/10.1016/j.njas.2011.04.002

8. Cardoso, C. S., Hötzel, M. J., Weary, D. M., Robbins, J. A., & von Keyserlingk, M. A. G. (2016). Imagining the ideal dairy farm. Journal of Dairy Science, 99(2), 1663–1671. https://doi.org/10.3168/jds.2015-9925

9. Connor, E. E. (2015). Invited review: Improving feed efficiency in dairy production: Challenges and possibilities. Animal, 9(3), 395–408. https://doi.org/10.1017/S1751731114002997

10. Connor, E. E., Hutchison, J. L., Olson, K. M., & Norman, H. D. (2012). Triennial lactation symposium: Opportunities for improving milk production efficiency in dairy cattle. Journal of Animal Science, 90(1), 1687–1694. https://doi.org/10.2527/jas.2011-4528

11. Dijkstra, T. K., & Henseler, J. (2015). Kleve: Composite Modeling. ADANCO 1.1. http://www.compositemodeling.com.

12. Douphrate, D. I., Hagevoort, G. R., Nonnenmann, M. W., Lunner Kolstrup, C., Reynolds, S. J., Jakob, M., & Kinsel, M. (2013). The Dairy Industry: A Brief Description of Production Practices, Trends, and Farm Characteristics Around the World. Journal of Agromedicine, 18(1), 187–197. https://doi.org/10.1080/1059924X.2013.796901

13. Egger-Danner, C., Köck, A., Fuchs, K., Grassauer, B., Fuerst-Waltl, B., & Obritzhauser, W. (2020). Use of benchmarking to monitor and analyze effects of herd size and herd milk yield on cattle health and welfare in Austrian dairy farms. Journal of Dairy Science. https://doi.org/10.3168/jds.2019-16745

14. Erickson, P. S., & Kalscheur, K. F. (2020). Nutrition and feeding of dairy cattle. In Animal Agriculture (pp. 157–180). https://doi.org/10.1016/b978-0-12-817052-6.00009-4

15. FAO. (2020). Global Dairy Industry Factsheet 2020: World's Top 10 Largest Milk Producing Countries, Top Milk Exporters and Milk Importers. Institution of Environment of Acre, BizVibe. https://www.bizvibe.com/blog/food-beverages/top-10-largest-milk-producing-countries/

16. Feroze, S. M., Singh, R., & Sirohi, S. (2016). Profitability and disposal pattern of milk in underdeveloped hill production system of Meghalaya. Indian Journal of Animal Sciences, 86(10), 1198–1203.

17. Feroze, S. M., Singh, R., & Sirohi, S. (2019). Economics of milk production and factors affecting milk yield in Meghalaya: Estimating the seasonal effect. Indian Journal of Dairy Science, 72(3), 328–335. https://doi.org/10.33785/ijds.2019.v72i03.014

18. Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. Journal of Marketing Research, 18(1), 39–50. https://doi.org/10.2307/3151312

19. Garcia, S. N., Osburn, B. I., & Cullor, J. S. (2019). A one health perspective on dairy production and dairy food safety. One Health, 7(1), 100086. https://doi.org/10.1016/j.onehlt.2019.100086

20. GoTN. (2020). Dairy Development Policy Note 2019-2020. https://cms.tn.gov.in/sites/default/files/documents/dairy_e_2019_20_pn.pdf

21. Hair, Hult, G. T. M., Ringle, C. M., & Sarstedt, M. A. (2017). Primer on partial least squares structural equation modeling (PLS-SEM) (3rd ed.). Sage Publication.

22. Hair, J., Hollingsworth, C. L., Randolph, A. B., & Chong, A. Y. L. (2017). An updated and expanded assessment of PLS-SEM in information systems research. Industrial Management and Data Systems, 117(1), 442–458. https://doi.org/10.1108/IMDS-04-2016-0130

23. Harrison, M. T., Cullen, B. R., & Armstrong, D. (2017). Management options for dairy farms under climate change: Effects of intensification, adaptation and simplification on pastures, milk production and profitability. Agricultural Systems, 155(1), 19–32. https://doi.org/10.1016/j.agsy.2017.04.003

24. Henseler, J., Hubona, G., & Ray, P. A. (2016). Using PLS path modeling in new technology research: Updated guidelines. Industrial Management and Data Systems, 116(1), 2-20. https://doi.org/10.1108/IMDS-09-2015-0382

25. Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science, 43(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

26. Hogenboom, J. A., Pellegrino, L., Sandrucci, A., Rosi, V., & D'Incecco, P. (2019). Invited review: Hygienic quality, composition, and technological performance of raw milk obtained by robotic milking of cows. Journal of Dairy Science, 102(9), 7640–7654. https://doi.org/10.3168/jds.2018-16013

27. IBEF. (2020). Indian Agriculture and Allied Industries Industry Report. Agriculture in India: Information About Indian Agriculture & Its Importance. https://www.ibef.org/industry/agriculture-india.aspx

28. ITC. (2020). Top Milk Importing & Exporting Countries. International Trade Center, BizVibe. https://www.trademap.org/Index.aspx?AspxAutoDetectCookieSupport=1

29. Jain, P., Satapathy, T., & Pandey, R. K. (2020). Rhipicephalus microplus: A parasite threatening cattle health and consequences of herbal acaricides for upliftment of livelihood of cattle rearing communities in Chhattisgarh. Biocatalysis and Agricultural Biotechnology, 26(1), 101611. https://doi.org/10.1016/j.bcab.2020.101611

30. Janssen, E., & Swinnen, J. (2019). Technology adoption and value chains in developing countries: Evidence from dairy in India. Food Policy, 83(1), 327–336. https://doi.org/10.1016/j.foodpol.2017.08.005

31. Joshi, P. K. (2015). Has Indian agriculture become crowded and risky? Status, implications and the way forward. Indian Journal of Agricultural Economics, 70(1), 1–41.

32. Kant, K., Sankhala, G., Prasad, K., & Kadian, K. S. (2017). Adaptation practices followed by dairy farmers under adverse climatic conditions in western dry region of India. Indian Journal of Animal Sciences, 87(2), 215–222.

33. Keshavarzi, H., Sadeghi-Sefidmazgi, A., Ghorbani, G., Kowsar, R., Razmkabir, M., & Amer, P. (2020). Effect of abortion on milk production, health, and reproductive performance of Holstein dairy cattle. Animal Reproduction Science, 217(1), 106458.

34. Kunte, B. S., & Patankar, S. (2015). A Literature Review of Indian Dairy Industry. International Journal of Management Research & Review, 5(6), 341–350.

35. Lambertz, C., Sanker, C., & Gauly, M. (2014). Climatic effects on milk production traits and somatic cell score in lactating Holstein-Friesian cows in different housing systems. Journal of Dairy Science, 97(1), 319–329. https://doi.org/10.3168/jds.2013-7217

36. Landes, M., Cessna, J., Kuberka, L., & Jones, K. (2017). India's dairy sector: structure, performance, and prospects. A Report from the Economic Research Service. www.ers.usda.gov

37. Malaver, Y. Y. V., Claudio, B. A. M., & Ruiz, J. A. Z. (2024). Quality of service and user satisfaction of a police station in a district of northern Lima. Southern Perspective / Perspectiva Austral, 2, 20–20. https://doi.org/10.56294/pa202420

38. Marcelo, K. V. G., Claudio, B. A. M., & Ruiz, J. A. Z. (2023). Impact of Work Motivation on service advisors of a public institution in North Lima. Southern Perspective / Perspectiva Austral, 1, 11–11. https://doi.org/10.56294/pa202311

39. Marcondes, M. I., Jácome, D. C., da Silva, A. L., Rennó, L. N., & Pires, A. C. dos S. (2014). Evaluation of raw milk quality in different production systems and periods of the year. Revista Brasileira de Zootecnia, 43(12), 670–676. https://doi.org/10.1590/S1516-35982014001200007

40. Martin, L. van der L. (2015). Beyond traditional dairy veterinary services: "It's not just about the cows!" Journal of the South African Veterinary Association, 86(1), 1221. https://doi.org/10.4102/jsava.v86i1.1221

41. Martínez, M. C. H., & Medina, M. A. G. (2024). Impact of Toxic Substance Use on Quality of Life in Adolescents. Health Leadership and Quality of Life, 3, 42–42. https://doi.org/10.56294/hl202442

42. Martono, S., Negara, W., Gopar, R. A., & Rofiq, M. N. (2016). Combination Effect of Feed Supplements on Milk Yield and Milk Quality of Dairy Cattle. Journal of Advanced Agricultural Technologies, 3(2), 136–139. https://doi.org/10.18178/joaat.3.2.136-139

43. Mayberry, D., Ash, A., Prestwidge, D., Godde, C. M., Henderson, B., Duncan, A., Blummel, M., Ramana Reddy, Y., & Herrero, M. (2017). Yield gap analyses to estimate attainable bovine milk yields and evaluate options to increase production in Ethiopia and India. Agricultural Systems, 155(1), 43–51. https://doi.org/10.1016/j.agsy.2017.04.007

44. Merino, V. M., Balocchi, O. A., & Rivero, M. J. (2019). Milk production, milk quality, and behaviour of dairy cows grazing on swards with low and high water-soluble carbohydrates content in autumn: A pilot trial. Animals, 9(12), 1–11. https://doi.org/10.3390/ani9121012

45. Mitiku, E., Mekdes, S., & Yesihak, Y. M. (2019). Milk production, marketing practices and qualities along milk supply chains of Haramaya District, Ethiopia. African Journal of Agricultural Research, 14(35), 1990–2005. https://doi.org/10.5897/ajar2019.14087

46. Mogotu, M. W., Abong, G. O., Mburu, J., & Ndambi, O. A. (2022). Assessment of hygiene practices and microbial safety of milk supplied by smallholder farmers to processors in selected counties in Kenya. Tropical Animal Health and Production, 54(4), 1–13. https://doi.org/10.1007/s11250-022-03214-7

47. Moorby, J. M., Evans, R. T., Scollan, N. D., MacRae, J. C., & Theodorou, M. K. (2006). Increased concentration of water-soluble carbohydrate in perennial ryegrass (Lolium perenne L.). Evaluation in dairy cows in early lactation. Grass and Forage Science, 61, 52–59. https://doi.org/10.1111/j.1365-2494.2006.00507.x

48. Mullan, S., Bunglavan, S. J., Rowe, E., Barrett, D. C., Lee, M. R. F., Ananth, D., & Tarlton, J. (2020). Welfare challenges of dairy cows in India identified through on-farm observations. Animals, 10(4), 586. https://doi.org/10.3390/ani10040586

49. NDRI. (2016). Institute Cattle Yard. Livestock Farm. http://www.ndri.res.in/ndri/Design/livestock_farm.html

50. Ñope, E. M. G., Claudio, B. A. M., & Ruiz, J. A. Z. (2023). The Service Quality of a Feed Industry Company. Southern Perspective / Perspectiva Austral, 1, 9–9. https://doi.org/10.56294/pa20239

51. Okano, M. T. (2017). Interorganisational networks and social innovation: A study in milk production chain. International Journal of Innovation and Sustainable Development, 11(4), 317–335. https://doi.org/10.1504/IJISD.2017.086868

52. Ouellet, V., Cabrera, V. E., Fadul-Pacheco, L., & Charbonneau. (2019). The relationship between the number of consecutive days with heat stress and milk production of Holstein dairy cows raised in a humid continental climate. Journal of Dairy Science, 102(9), 8537–8545. https://doi.org/10.3168/jds.2018-16060

53. Owusu-Kwarteng, J., Akabanda, F., Agyei, D., & Jespersen, L. (2020). Microbial safety of milk production and fermented dairy products in africa. Microorganisms, 8(5), 752. https://doi.org/10.3390/microorganisms8050752

54. Pandian, S. S. A., Shree, J., Boopathy, R. M., & Vetrivel, D. (2013). Analyzing the Cost and Returns of Urban Milk Production in Tamil Nadu. International Journal of Food, Agriculture and VeterinarySciences, 3(2), 1–5.

55. Patel, A. (2016). Enhancing Milk Productivity, Output & Quality in India. International Journal of Scientific Research in Science and Technology, 2(5), 22–30.

56. Pereira, M. C. S., Dellaqua, J. V. T., Sousa, O. A., Santi, P. F., Felizari, L. D., Reis, B. Q., Pinto, A. C. J., Bertoldi, G. P., Silvestre, A. M., Watanabe, D. H. M., Estevam, D. D., Arrigoni, M. D. B., & Millen, D. D. (2020). Feedlot performance, feeding behavior, carcass and rumen morphometrics characteristics of Nellore cattle submitted to strategic diets prior the adaptation period. Livestock Science, 234(1), 103985. https://doi.org/10.1016/j.livsci.2020.103985

57. Picinin, L. C. A., Bordignon-Luiz, M. T., Cerqueira, M. M. O. P., Toaldo, I. M., Souza, F. N., Leite, M. O., Fonseca, L. M., & Lana, A. M. Q. (2019). Effect of seasonal conditions and milk management practices on bulk milk quality in Minas Gerais State - Brazil. Arquivo Brasileiro de Medicina Veterinaria e Zootecnia, 71(4), 1355–1363. https://doi.org/10.1590/1678-4162-10063

58. Prasad, C. S., Anandan, S., Gowda, N. K. S., Schlecht, E., & Buerkert, A. (2019). Managing nutrient flows in Indian urban and peri-urban livestock systems. Nutrient Cycling in Agroecosystems, 115(1), 159–172. https://doi.org/10.1007/s10705-018-9964-0

59. Rao, D. (2016). Safety of Milk Processing and Distribution Chain in India. In Regulating Safety of Traditional and Ethnic Foods (pp. 169–185). https://doi.org/10.1016/B978-0-12-800605-4.00009-8

60. Reddy, A. A., Raju, S. S., Suresh, A., & Kumar, P. (2018). Analysis of pearl millet market structure and value chain in India. Journal of Agribusiness in Developing and Emerging Economies, 8(1), 1–19. https://doi.org/10.1108/JADEE-02-2016-0007

61. Reddy, A. S., & Padmavathi, M. (2016). The Growth and Development of Dairy Industry in India. International Journal of Scientific Research, 5(6), 426–429.

62. Reporter, S. (2016, September 20). Varanasi, Madurai on latest list of Smart Cities. The Hindu, 2. https://www.thehindu.com/news/national/Varanasi-Madurai-on-latest-list-of-Smart-Cities/article14990260.ece

63. Samal, L., & Pattanaik, A. (2014). Dairy Production in India - Existing Scenario and Future Prospects. International Journal of Livestock Research, 4(2), 105–113. https://doi.org/10.5455/ijlr.20131002065611

64. Sankar, J. P. (2016a). Problems and Constraints Faced by Milk Producers and Milk Co-operative Societies in Tamil Nadu with Special Reference to Vellore District. Research Directions, 3(11), 1–10.

65. Sankar, J. P. (2016b). Various Channels of Milk Marketing In Tamil Nadu with Special Reference to Vellore District. Indian Streams Research Journal, 6(5), 1–8.

66. Sankar, J. P., & Yoganandham, G. (2016). Milk Co-operatives in Tamil Nadu - An Impact Assessment (J. P. Sankar & G. Yoganandham (eds.); 1st ed.). Lulu Publication.

67. Sankar, J. P., & Yoganandham, G. (2021). Factors Affecting the Quality of Milk Productivity from the Perspective of Dairy Farmers in India. Journal of Environment and Bio-Sciences, 35(1), 65–75.

68. Shahbandeh, M. (2020). Global cow milk production 2015 to 2019. Statista. https://www.statista.com/statistics/263952/production-of-milk-worldwide/

69. Shahjahan, M. (2017). High yielding dairy cattle husbandry and their production performance at Baghabari Milk Vita areas of Bangladesh. Asian-Australasian Journal of Bioscience and Biotechnology, 2(1), 60–67.

70. Sharma, A., Kennedy, U., Schuetze, C., & Phillips, C. J. C. (2019). The Welfare of Cows in Indian Shelters. Animals, 9(4), 1–26. https://doi.org/10.3390/ani9040172

71. Singh, A., & Srivastava, R. (2019). Seasonal variations in milk procurement and milk marketing: a case of the Rajasthan Co-operative Dairy Federation, India. International Journal of Management Concepts and Philosophy, 12(3), 239–254. https://doi.org/10.1504/ijmcp.2019.100676

72. Stephansen, R. S., Fogh, A., & Norberg, E. (2018). Genetic parameters for handling and milking temperament in Danish first-parity Holstein cows. Journal of Dairy Science, 101(12), 11033–11039. https://doi.org/10.3168/jds.2018-14804

73. Susanti, S., & Marhaeniyanto, E. (2007). Correlation between Nitrogen digestibility and retention with milk production in crossbreed friessian holstein with pollard and rice brand. Jurnal Protein, 15(2), 130–135.

74. Suzuki, K., & Pfeiffer, D. U. (2009). Characteristics of rural smallholder communities in northern vietnam, with particular emphasis on dairy farming. International Journal of Agricultural Resources, Governance and Ecology, 8(2–4), 334–349. https://doi.org/10.1504/ijarge.2009.026233

75. Teresiah, W. N., Patrick, S. M., Mary, O., Gerard, O., & Anton, J. (2016). Quality control of raw milk in the smallholder collection and bulking enterprises in Nakuru and Nyandarua Counties, Kenya. African Journal of Food Science, 10(5), 70–78. https://doi.org/10.5897/ajfs2015.1412

76. Thanh, L. P., & Suksombat, W. (2015). Milk production and income over feed costs in dairy cows

fed medium-roasted soybean meal and corn dried distiller's grains with solubles. Asian-Australasian Journal of Animal Sciences, 28(4), 519–529. https://doi.org/10.5713/ajas.14.0685

77. Tricarico, J. M., Kebreab, E., & Wattiaux, M. A. (2020). Sustainability of dairy production and consumption in low-income countries with emphasis on productivity and environmental impact. Journal of Dairy Science, 103(11), 9791–9802.

78. Umamageswari, M., Dixit, P. K., & Sivaram, M. (2017). Economics of milk production in Tamil Nadu - a comparative study. Indian Journal of Dairy Science, 70(2), 221–227.

79. Vandehaar, M. J., & St-Pierre, N. (2006). Major advances in nutrition: Relevance to the sustainability of the dairy industry. Journal of Dairy Science, 89(4), 1280–1291. https://doi.org/10.3168/jds.S0022-0302(06)72196-8

80. Velásquez, A. A., Gómez, J. A. Y., Claudio, B. A. M., & Ruiz, J. A. Z. (2024). Soft skills and the labor market insertion of students in the last cycles of administration at a university in northern Lima. Southern Perspective / Perspectiva Austral, 2, 21–21. https://doi.org/10.56294/pa202421

81. Viera, E. J. H., Meléndez, N. M. N., Claudio, M. C. M., & Ruiz, J. A. Z. (2023). Selection process in the Operations area of a company in the ecological sector. Southern Perspective / Perspectiva Austral, 1, 13–13. https://doi.org/10.56294/pa202313

82. Visioli, F., & Strata, A. (2014). Milk, dairy products, and their functional effects in humans: A narrative review of recent evidence. Advances in Nutrition, 5(2), 131–143. https://doi.org/10.3945/an.113.005025

83. Vries, A. De, Kaylegian, K. E., & Dahl, G. E. (2020). MILK Symposium review: Improving the productivity, quality, and safety of milk in Rwanda and Nepal. Journal of Dairy Science, 103(11), 9758–9773.

84. Wanapat, M., Foiklang, S., Sukjai, S., Tamkhonburi, P., Gunun, N., Gunun, P., Phesatcha, K., Norrapoke, T., & Kang, S. (2018). Feeding tropical dairy cattle with local protein and energy sources for sustainable production. Journal of Applied Animal Research, 46(1), 232–236. https://doi.org/10.1080/09712119.2017.1288627

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

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