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Front line demonstration on integrated dairy management: A scientific field-based assessment of productivity and profitability in dairy cows

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Abstract

Dairy farming is a major livelihood activity in rural India; however, its productivity is often constrained by poor feeding practices, inadequate preventive healthcare, mineral deficiency, and subclinical mastitis. Front Line Demonstrations (FLDs) conducted by the Indian Council of Agricultural Research-Krishi Vigyan Kendra, Bidar, on Integrated Dairy Management (IDM) were designed to address these practical field-level constraints under farmers' conditions. According to the demonstration records, the interventions were implemented among 10 dairy farmers in Narayanpur and Dhannur villages of Bidar District in Karnataka, where the major problems identified were low milk yield, low fat and SNF content and poor health management practices, including irregular deworming and udder care. The IDM included bypass fat supplementation, area-specific mineral mixtures, deworming, vaccination, mastitis control, urea treatment of dry fodder, and silage preparation. The three-year field trial (2020-21 to 2022-23) demonstrated significant improvements in milk production (31.50-38.00% increase), quality parameters, animal health, and economic returns. The benefit-cost ratio improved from 3.75-4.20 (check practice) to 4.40-4.50 (demonstrated practice). Scientific literature also supports that improved nutrition, mineral supplementation, and better herd health management significantly enhance milk production and economic efficiency in smallholder dairy farming systems in developing countries. This study provides robust, three-year-field-based evidence quantifying the economic and productivity gains of IDM via FLDs in a specific Indian smallholder context, offering a replicable model for extension agencies and demonstrating the potential for significant farmer income enhancement.

Keywords: Integrated Dairy Management (IDM), Front Line Demonstrations (FLDs), dairy farming

1. Introduction

Dairy farming is integral part of Indian economy as well as many developing countries since so many years. It plays an important role in upliftment of rural farmers by providing stable income source in the form of milk (Pranita Lawale, 2023) ^[9]. Majority of the dairy farmers are and landless and marginal who are illiterate and are not aware of economic aspect of milk production (Singh and Sastry, 2002) ^[12]. Other developmental aspects such as poverty alleviation,

prevention of malnutrition, reduction of hunger index can be significantly achieved by means of dairy farming. India is the highest milk producing country in the world but the average productivity of each animal is very less i.e., average daily milk yield of buffaloes, cross breed cattle, indigenous cattle was 6.01, 5.79, and 5.45 litres/day/animal respectively (Meena et al., 2016) ^[8]. This low productivity of Indian animals is may be due to the lack of awareness and adoption of improved dairy management practices to the farmers. The

modern aspects of dairy farming are mainly based on the improved practices like, balanced ration feeding, selection of the dairy animals for productive and reproductive purposes and proper healthcare measures. The present study was therefore carried out to assess the adoption level of improved dairy management practices by the farmers. Remarkable progress in the area of livestock development. India has largest livestock population in the world. The total livestock population of India makes up a huge numbers and stands first in cattle and buffalo population, second in goats and third in sheep in the world. India has 57% of the world's buffalo population. Livestock rearing in rural systems is not the primary occupation for the rural population, but serves instead as a support enterprise to agriculture. Mixed herds with goats, sheep, cattle and buffaloes are found in this system. Cattle are reared primarily for drought power and manure, rather than for milk. In this system, crop residues and grazing in community lands form major source of fodder. Bhise. R. N. et.al. (2018) ^[10]. Dairying plays an important role in the livelihood security of rural households by providing regular income, employment opportunities, and household nutrition. However, the productivity of dairy animals in smallholder systems often remains below their potential because the management is fragmented rather than integrated (Kibreab *et al.*, 2019). Dairy farming is one of the important activities of the rural population of our country. Dairy is the most suitable production system that has enormous potential to improve the socioeconomic status of the large percentage of the rural population. While the bulk of milk production is in the hands of numerous landless, marginal and small farmers scattered all over the country. India's livestock sector is one of the largest sectors in the world. It has been demonstrated in a study that there exists a close relationship between livestock farmers personal characteristics, attitude and management practices and farm performance Mali. K.N. *et al.* (2014) ^[7]. In many field situations, farmers follow traditional feeding and health practices, such as feeding dry fodder without enrichment, irregular deworming, lack of mineral supplementation, and insufficient mastitis prevention, all of which reduce the milk yield and quality. Despite existing knowledge on individual interventions, a significant research gap remains in understanding the holistic impact and effective demonstration of integrated dairy management strategies under the specific, heterogeneous conditions of smallholder Indian farms, Ritchie H *et al.* (2020) ^[11]. While technologies exist, the challenge lies in effectively demonstrating their practical benefits and quantifying their combined impact under real farm conditions, particularly concerning the socio-economic factors influencing adoption in specific Indian dairy farming systems.

Frontline demonstrations are an important extension approach used to show the visible impact of recommended technologies directly on farmers' fields. Such demonstrations are especially useful in livestock systems because farmers are more likely to adopt practices that produce clear improvements in milk yield, body condition, reproductive response, and profits (Jayalalitha *et al.*, 2022) ^[12]. Scientific evidence from tropical smallholder dairy systems has shown that farm management strategies related to nutrition, disease prevention, and improved husbandry can substantially improve milk production (Bateki *et al.*,

2020) ^[1]. Integrated dairy management, therefore, represents a practical package approach in which feeding, health care, hygiene, and fodder conservation are addressed together rather than separately (Kibreab *et al.*, 2019).

The current study aimed to address the key production constraints identified in the villages of Narayanpur and Dhannur. The major problems recorded before the intervention were low milk yield, low fat and SNF percentage, and worm infestation in calves, along with poor deworming and vaccination practices.

Materials and Methods

Study area and participants

The FLDs on Integrated Dairy Management were conducted by ICAR-Krishi Vigyan Kendra, Bidar, with technical support from KVAFSU, Bidar. Ten farmers were purposively selected from Narayanpur and Dhannur villages based on criteria such as willingness to participate and having at least two dairy cows to allow for within-farm comparison. Acknowledging the small sample size, this pilot demonstration focused on illustrating the impact under real-farm conditions rather than generating statistically generalizable results. Future studies should expand the sample size for broader statistical inferences. The approach was comparative in nature, where existing farmer practices served as the check, and the recommended integrated system served as the demonstration.

Problems identified before intervention

Baseline field observations indicate several management gaps. These included low milk yield, reduced milk fat and solids-not-fat (SNF), lack of bypass fat supplementation, irregular or absent deworming schedule, no proper vaccination schedule, inadequate mastitis control, lack of area-specific mineral mixture supplementation, feeding of only dry fodder without enrichment, and poor fodder conservation practices. Such limitations are known to negatively affect nutrient utilization, milk synthesis, reproductive efficiency, and udder health in dairy animals (Joint, F. A. O. 1999; Bateki *et al.*, 2020) ^[3, 1].

Integrated dairy management technologies demonstrated

The demonstration package consists of several complementary interventions. Bypass fat in the form of Fatomax was provided at 100 g/day/animal for 90 days, amounting to approximately 9 kg/animal. A deworming bolus was administered at 3 g per adult cow, and vaccination against hemorrhagic septicemia (HS), black quarter (BQ), and foot-and-mouth disease (FMD) was performed according to the recommended schedule. A recommended schedule is as follows: A CMT-based mastitis control practice along with a supportive spray to udder hygiene and reduce subclinical mastitis. Area-specific mineral mixture was supplemented at 50 g/day/cow, dry fodder was enriched using urea treatment, and silage production was demonstrated as a method of fodder conservation. (Lahoti, S. R. and R. R. Chole, 2010) ^[6].

These practices are scientifically justified because balanced energy supplementation improves milk output and body condition, mineral supplementation corrects nutrient deficiency, and regular health care reduces production

losses associated with parasitism and infectious diseases (Bateki *et al.*, 2020) ^[1]. Integrated approaches are generally more effective than isolated interventions because milk production depends on the interaction between nutrition, health status, and environmental management.

Data recorded and economic assessment

The main parameters recorded in the FLD were milk yield (L/cow/day), corrected lactometer reading (CLR), fat percentage, SNF percentage, subclinical mastitis incidence, and body condition score on a 0–5 scale. Economic analysis was also performed by comparing the gross cost, gross return, net return, and benefit-to-cost (B:C) ratio between the farmer practice and demonstration groups. Milk sale price was considered as Rs. 40 per liter for calculating returns during the 2022–23 assessment. The total cost of critical inputs for the demonstration group over the three-year period amounted to Rs. 32,000 for the 10 participating farmers. This cost primarily covered bypass fat, mineral mixture, deworming medicine, and vaccines. These input costs were factored into the daily gross cost per cow for the economic analysis.

Results

Effect on milk yield and milk quality

The demonstration results over three years clearly showed that integrated dairy management improved milk yield over the prevailing farmer practice. During 2020–21, the average milk yield increased from 10.00 L/cow/day in the Practice group to 13.50 L/cow/day in the demonstration group, representing a 35 percent increase. In 2021–22, the milk yield increased from 10.50 to 14.50 L/cow/day, corresponding to a 38 percent increase. In 2022–23, the practice animals produced 9.50 L/cow/day, whereas the demonstration animals produced 12.50 L/cow/day, indicating a 31.50 percent increase.

Milk composition also consistently improved during the demonstration. Fat percentage increased from 3.20 to 4.50 in 2020–21, from 3.30 to 4.70 in 2021–22 and from 3.20 to 4.30 in 2022–23. Similarly, SNF improved from 8.00 to 8.70 in 2020–21, from 7.90 to 8.90 in 2021–22 and from 7.90 to 8.80 in 2022–23. CLR values also improved from 27.5 to 29.0, 27.0 to 29.5, and 27.0 to 29.5 across the three years. These findings are biologically meaningful because better energy and mineral nutrition are known to improve milk solids and overall lactational performance (Joint, 1999;

Bateki *et al.*, 2020) ^[3, 1].

Effect on animal health and body condition

Subclinical mastitis was recorded in the farmers practice group as one case each year, whereas no incidence was reported in the demonstration group across the study period. The body condition score improved from 3.0 to 4.0 in all three years under the demonstration system, suggesting that integrated management not only improved production but also strengthened animal health and welfare. As per the Joint F. A. O. 1999 ^[3], improvements in body condition are particularly important because they reflect better nutrient balance and often support improved reproductive response and persistence of lactation. Study conducted by Kaur *et al.* (2022) ^[4] observed similar farmer's feedback stating that estrus signs appeared early, around 90 days after parturition, and that animals changed from a dull, rough skin coat to a shining skin coat. These observations, although qualitative, are consistent with the expected field response to better nutrition, mineral intake, and health care.

Economic impact of the demonstration

The economic analysis showed a clear financial advantage of the demonstration management practices over the traditional practices. In 2020–21, the gross cost in the practice group was Rs. 80/cow/day and the gross return was Rs. 300/cow/day, resulting in a net return of Rs. 220 and a B:C ratio of 3.75. In contrast, the demonstration group had a gross cost of Rs. 90/cow/day and a gross return of Rs. 405/cow/day, resulting in a net return of Rs. 315 and a B:C ratio of 4.5. In 2021–22, the practice group recorded a net return of Rs. 235 with a B:C ratio of 3.9, whereas the demonstration group recorded a net return of Rs. 335 with a B:C ratio of 4.4. In 2022–23, the demonstration group again outperformed the farmer practice group, with net returns of Rs. 390 versus Rs. 290 and B:C ratios of 4.5 versus 4.2. These results indicate that the increased cost of improved management was more than compensated for by the gains in milk output and quality. Similar evidence has been observed in previous studies. Bateki *et al.* (2020) ^[1] and Jayalalitha *et al.* (2022) ^[2] showed that management strategies focusing on feeding and health care can cost-effectively improve productivity and profitability. For resource-poor dairy farmers, this is important because adoption depends not only on biological performance but also on visible economic returns of the technology.

Table 1: The major outcomes recorded from the FLD

Sl. No.	Parameter	Farmer practice	Demonstration
1.	Milk yield, 2020–21 (L/cow/day)	10.00	13.50
2.	Milk yield, 2021–22 (L/cow/day)	10.50	14.50
3.	Milk yield, 2022–23 (L/cow/day)	9.50	12.50
4.	Fat%, 2022–23	3.20	4.30
5.	SNF%, 2022–23	7.90	8.80
6.	Subclinical mastitis	One case observed	No incidence
7.	Body condition score	3.0	4.0
8.	Farmer feedback	Delayed visible improvement	Early estrus, shiny coat, better milk traits

Discussion

The present FLD provides a strong field-level example of how the management practices of integrated dairy interventions can generate measurable improvements in

production, milk quality, animal health, and income under the farmer conditions. As per the previous study Kibreab *et al.* observed that rather than relying on a single technology, the demonstration addressed multiple bottlenecks

simultaneously. This is an important strength because dairy productivity is influenced by interconnected factors, including energy intake, mineral balance, udder health, disease control, and feed management. The increase in milk yield observed in the present demonstrations, ranging from 31.50 to 38 percent, is in agreement with broader scientific evidence from tropical smallholder dairy systems. A meta-analysis study by Bateki *et al.* (2020) ^[1] and Kaur *et al.* (2022) ^[4] stated that on-farm management strategies reported that improvements in management can significantly raise milk yields when nutrition and husbandry constraints are addressed together. Similarly, Joint, F. A. O. (1999) ^[3] stated that international technical guidance on improving dairy productivity under smallholder conditions has emphasized strategic supplementation, health care and better feed resource use as key factors for higher output and improved reproductive function. The findings from Bidar fit well within this scientific understanding.

The improvement in fat and SNF percentages also deserves attention because many dairy farmers are paid not only for milk volume but also for its quality. According to per F. A. O. (1999), bypass fat supplementation likely contributed to improved energy density in the ration, whereas mineral supplementation and better fodder management may have improved rumen efficiency and nutrient partitioning toward milk synthesis. Another study by Bateki *et al.* (2020) ^[1] showed that the absence of subclinical mastitis in demonstration animals also suggests that preventive udder care and mastitis screening can play a valuable role in maintaining milk quality and reducing hidden losses. Even when clinical signs are not obvious, subclinical mastitis lowers milk yield and can adversely affect milk composition, making simple screening methods highly valuable for fieldwork.

A study conducted by Jayalalitha *et al.* (2022) ^[2] observed that an equally important aspect of the FLD was its human dimension. Farmers reportedly observed earlier estrus, improved skin texture and visible improvement in animal appearance after the interventions. Such farmer-perceived benefits often drive adoption more effectively than technical explanation alone. Front-line demonstrations are especially successful when they create trust through visible and local evidence. In this sense, the FLD did not merely transfer technologies; it translated scientific recommendations into practical and understandable outcomes for the dairy farmers.

Limitation

This study, while demonstrating significant practical improvements, has some limitations. First, the small sample size of ten farmers, although typical for FLDs, limits the statistical power and generalizability of the findings. Second, while an economic analysis was performed, a dedicated cost-benefit analysis accounting for all potential external factors or long-term sustainability was beyond the scope of this demonstration. Third, the study did not include a rigorous statistical comparison between the farmer practice and demonstration groups, relying instead on direct observational comparisons. Future research should address these aspects to provide more robust scientific evidence.

Conclusion

The present Demonstrations on Integrated Dairy

Management conducted in Bidar district clearly demonstrated that coordinated dairy management practices, such as improved feeding, mineral supplementation, preventive health care, mastitis control, and fodder management, can substantially improve dairy performance under village conditions. Beyond simply confirming the efficacy of IDM, this three-year FLD uniquely quantifies the long-term compounding benefits across multiple parameters (milk yield, milk fat-to-SNF ratio, improved body condition score, no subclinical mastitis, and better economic returns) under real-world smallholder conditions, providing empirical data critical for policy and extension program design. These results are strongly supported by published scientific evidence demonstrating that integrated management strategies effectively improve productivity and profitability in smallholder dairy farming systems. This study highlights the practical value of FLDs as an extension method for livestock development in the country. When farmers observe measurable improvements directly in their environment, the likelihood of adoption increases substantially. Wider promotion of integrated dairy management through ICAR Krishi Vigyan Kendras and allied extension agencies could contribute meaningfully to increased milk production, better animal health, and enhanced livelihood security in rural communities.

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