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Impact of azolla supplementation on milk yield and economics of dairy animals under on farm trial

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Abstract

The present study was conducted to evaluate the impact of Azolla supplementation on milk production performance and economic returns of lactating cows under field conditions through On Farm Trail (OFT). A total of 20 lactating cows were selected and divided into two groups: control (T_1), following farmers' existing feeding practice, and treatment (T_2), where Azolla was supplemented in the daily ration. Milk yield was recorded at 30-day intervals up to 120 days. The results revealed a declining trend in milk yield under the control group, with an overall reduction of 8.64 per cent, whereas cows supplemented with Azolla exhibited a consistent increase in milk yield, registering an average improvement of 9.73 per cent over the experimental period. The average milk yield was higher in the Azolla supplemented group (8.00 L/day) compared to the control (6.87 L/day). Economic analysis indicated a reduction in feeding cost from ₹190 to ₹178 per animal per day after Azolla supplementation, while gross return increased from ₹280 to ₹320 per day. Consequently, net profit increased by ₹52 per animal per day and the benefit-cost ratio improved from 1.47 to 1.80. The study concluded that Azolla supplementation is an effective, low-cost and sustainable nutritional intervention for enhancing milk production and profitability of dairy cows under smallholder farming systems.

Keywords: Azolla, milk yield, lactating cows, On Farm Trail (OFT), economics, benefit-cost ratio

Introduction

Dairying plays a vital role in the livelihood security of small and marginal farmers in India by providing regular income, nutritional security and employment. However, productivity of dairy animals under field conditions remains low due to imbalanced feeding practices, high cost of conventional concentrate feeds and limited availability of quality protein sources. Feed cost alone accounts for nearly 60-70 per cent of the total cost of milk production, making economical feeding strategies essential for sustainable dairy development (Kumar *et al.*, 2020) [2].

Azolla, a free-floating aquatic fern belonging to the family Azollaceae, has emerged as a potential unconventional feed resource for dairy animals due to its high crude protein content, essential amino acids, minerals and vitamins. Azolla is rich in calcium, iron, phosphorus and β-carotene and possesses good digestibility, making it a suitable natural protein supplement for lactating animals. Its rapid growth, low input requirement and ease of on-farm cultivation further enhance its suitability for adoption by smallholder farmers (Basak *et al.*, 2002) [1].

Several studies have reported the beneficial effects of Azolla supplementation on milk yield and milk composition in dairy cattle and buffaloes. Supplementation of Azolla improves rumen microbial activity, enhances nutrient utilization efficiency and supports better lactation persistence, resulting in increased milk production (Cherryl *et al.*, 2014) [3]. Despite its proven nutritional potential, large-scale adoption of Azolla feeding remains limited under farmers' field conditions due to lack of awareness and location-specific validation.

On Farm Trail (OFT) conducted through Mahayogi Gorakhnah Krishi Vigyan Kendras (MGKVK) serve as an effective extension tool for assessing the performance, economic viability and adoptability of improved technologies under farmers' field conditions. Evaluation of Azolla supplementation through OFT provides scientific evidence on its production and economic impact and facilitates its wider dissemination among farming communities.

In view of the above, the present study was undertaken to assess the impact of Azolla supplementation on milk production performance and economic returns of lactating cows under field conditions through On Farm Trail (OFT).

Materials and Methods

Experimental Site and Duration

The On Farm Trial (OFT) was conducted by Mahayogi Gorakhnath Krishi Vigyan Kendra (MGKVK) during the year 2019 and 2020 in selected villages of its operational area to evaluate the performance of Azolla supplementation in lactating cows under farmers' field conditions. The trial was conducted for a period of 120 days to assess its effect on milk production performance and economic returns.

Identification of Problem and Objective of OFT

The OFT was initiated to address the problem of declining milk yield and high feeding cost in lactating cows due to imbalanced feeding practices and inadequate protein supplementation under farmers' conditions. The specific objective of the trial was to assess the suitability, productivity and economic viability of Azolla supplementation as an alternative protein source in the daily ration of lactating cows.

Selection of Farmers and Animals

A total of 10 representative dairy farmers were selected for the trial. From each farmer, two lactating cows of similar parity, stage of lactation and milk yield were selected. Thus, a total of 20 lactating cows were included in the study. One cow from each farmer was maintained under farmers' practice (T_1), while the other cow was subjected to the improved practice (T_2) involving Azolla supplementation.

Treatments Details

The trial consisted of two treatments:

- **T_1 (Farmers' practice):** Feeding of green fodder, dry fodder and concentrate mixture as per existing farmer practice without Azolla supplementation.
- **T_2 (Improved practice):** Feeding as per farmers' practice along with supplementation of fresh Azolla @ 1.0-1.5 kg per animal per day.

Feeding and Management Practices

All the experimental animals were maintained under similar housing, management and health care practices. In the improved practice, freshly harvested Azolla was washed properly to remove excess water and mixed with concentrate feed before feeding. Clean drinking water was provided ad libitum to all animals throughout the experimental period.

Azolla Production Technique

Azolla was produced at the farmers' level using low-cost, on-farm production methods. Shallow pits or cemented tanks were used for Azolla cultivation with regular application of cow dung slurry and maintenance of optimum water depth. Farmers were trained by MGKVK scientists on Azolla cultivation, harvesting and feeding techniques as part of the OFT programme.

Recording of Observations

Milk yield of individual animals was recorded daily by the farmers and monitored by KVK scientists at regular intervals. The average daily milk yield was worked out at 30-day intervals, namely at initial stage (0 day), 30, 60, 90 and 120 days of the trial.

Economic Evaluation

Economic analysis of the trial was carried out by calculating feeding cost, gross return, net profit and benefit-cost ratio for both the treatments. Feeding cost was computed based on prevailing local market prices of feed ingredients. Gross return was calculated on the basis of milk yield and prevailing milk price of ₹40 per litre. Net profit was calculated by subtracting feeding cost from gross return, while the benefit-cost ratio was computed as the ratio of gross return to feeding cost.

Statistical Analysis

The data generated from the OFT were compiled and analyzed using descriptive statistics. Mean values were calculated to compare milk yield performance and economic parameters between farmers' practice and improved practice.

Results and Discussion

Milk production performance

The present study clearly demonstrated the beneficial effect of Azolla supplementation on milk production performance of lactating cows under field conditions (Table 1). The results indicated a consistent and progressive increase in milk yield in the Azolla supplemented group (T_2) throughout the 120-day experimental period, whereas a declining trend was observed in the control group (T_1).

In the control group, average milk yield decreased from 7.02 to 6.50 litres per day with an overall reduction of 8.64 per cent. This decline may be attributed to the advancing stage of lactation, seasonal stress, and absence of additional nutritional support, which is commonly observed under farmers' feeding practices. Similar declining trends in milk yield under non-supplemented conditions have been reported by earlier workers.

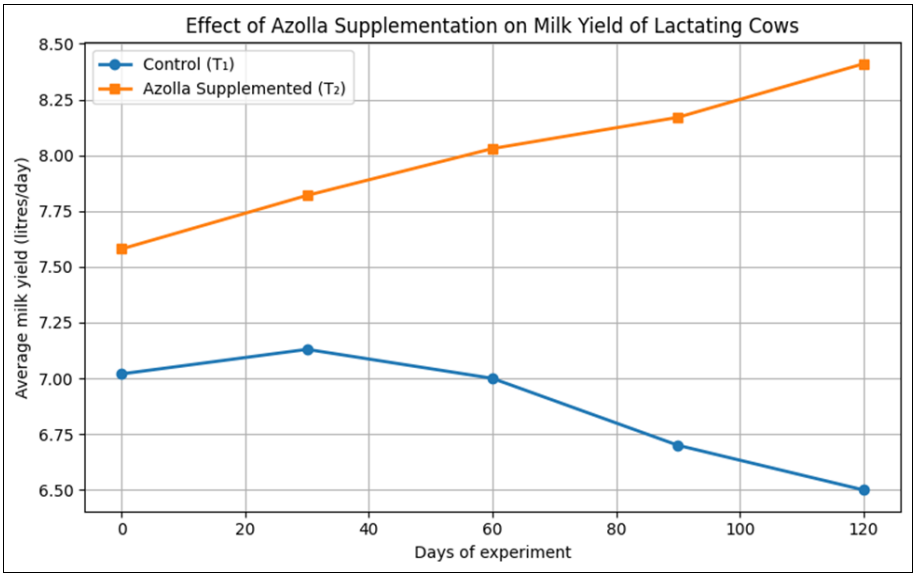
In contrast, cows supplemented with Azolla (T_2) recorded a steady increase in milk yield from 7.58 to 8.41 litres per day, registering an average improvement of 9.73 per cent over the experimental period. The enhanced milk production in the treatment group can be attributed to the high crude protein content, essential amino acids, minerals (especially calcium and iron), and vitamins present in Azolla, which improve rumen microbial activity and overall nutrient utilization efficiency. The improvement in milk production may be attributed to the high protein and mineral content of Azolla, which enhances nutrient utilization efficiency (Basak *et al.*, 2002) [1]. The average increase in milk yield observed in the present study ranged from 7 to 13 per cent. The findings are in close agreement with those of Nidhi *et al.* (2015) [5], who reported a significant increase of 11.85 per cent in milk production in Azolla-supplemented animals.

The sustained increase in milk yield in the Azolla supplemented group also indicates better persistence of lactation and improved metabolic efficiency. Azolla acts as a natural protein supplement and partially compensates for the protein deficiency commonly observed in conventional concentrate feeding under smallholder dairy systems. The results are in close conformity with earlier findings, which reported significant improvement in milk yield due to Azolla supplementation in dairy cattle under field and experimental conditions. Similar improvements in milk yield due to Azolla supplementation have also been reported earlier (Cherryl *et al.*, 2014) [3].

The comparative analysis between the two treatments revealed that Azolla supplementation not only prevented the decline in milk yield but also enhanced productivity under real farm situations, demonstrating its practical utility and farmer acceptability. Being a low-cost, locally producible and eco-friendly feed resource, Azolla supplementation offers a viable strategy for improving milk production and income of dairy farmers, particularly in resource-poor and smallholder farming systems. The observed impact under field conditions corroborates earlier findings reported by Kumar *et al.*, 2020 [2].

Table 1: Impact of azolla supplementation on milk production performance (liter) of lactating cows at 30 days interval

Treatment group	initial	30 days	60 days	90 days	120 days	Average Milk yield	Increased milk yield at 120 days	% Milk yield Increase
T_1 (Control)	5.6	5.8	5.86	5.56	5.16	5.60	-0.44	-8.53
	5.15	5.25	5.55	5.15	4.75	5.17	-0.4	-8.42
	8.4	8.6	8.75	8.8	8.9	8.69	0.5	5.62
	7.15	7.2	7	7	6.5	6.97	-0.65	-10.00
	8	7.75	7.5	7.5	7.3	7.61	-0.7	-9.59
	5.9	5.8	5.75	5.4	5.5	5.67	-0.4	-7.27
	10.5	10.8	10.2	9.5	9.7	10.14	-0.8	-8.25
	6.75	6.95	7.05	6.55	5.95	6.65	-0.8	-13.45
	6.75	6.9	6.2	5.75	5.85	6.29	-0.9	-15.38
	6	6.25	6.1	5.8	5.4	5.91	-0.6	-11.11
Average	7.02	7.13	7.00	6.70	6.50	6.87	-0.52	-8.64
T_2 (Treatment)	5.5	5.75	5.85	5.9	6	5.80	0.30	8.33
	9	9.5	9.8	10	10	9.66	0.66	10.00
	5.2	5.3	5.35	5.5	5.7	5.41	0.21	8.77
	7	7.25	7.6	7.65	7.95	7.49	0.49	11.95
	9.5	9.75	9.9	10.1	10.3	9.91	0.41	7.77
	8.25	8.45	8.6	8.75	8.9	8.59	0.34	7.30
	6.5	6.6	6.75	6.95	7	6.76	0.26	7.14
	7.5	7.65	7.9	8.1	8.8	7.99	0.49	14.77
	11	11.5	11.9	12	12.4	11.76	0.76	11.29
	6.3	6.4	6.6	6.75	7	6.61	0.31	10.00
Average	7.58	7.82	8.03	8.17	8.41	8.00	0.42	9.73



Economic Analysis of Azolla supplementation in Lactating Cows

The economic analysis of Azolla supplementation in lactating cows revealed a substantial improvement in profitability as compared to the existing farmers' feeding practice. The results clearly indicated that inclusion of Azolla in the daily ration not only enhanced milk yield but also reduced the overall feeding cost, thereby improving the benefit-cost ratio (Table 2).

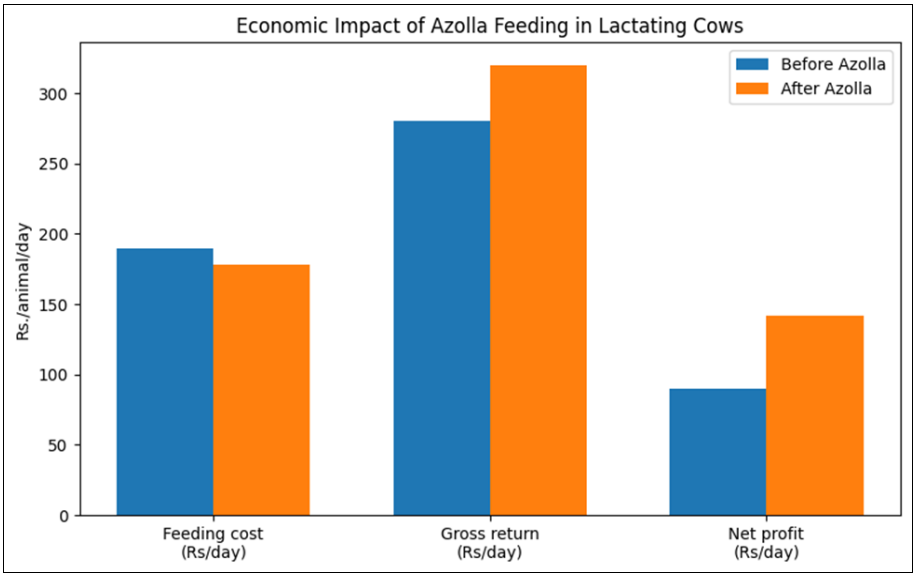
Prior to Azolla feeding, the average feeding cost per animal per day was ₹190, which reduced to ₹178 after Azolla supplementation. This reduction in feeding cost may be attributed to partial substitution of conventional concentrate feed with low-cost, on-farm produced Azolla. Consequently, the average feed cost per litre of milk marginally decreased from ₹23.00 to ₹22.70 after Azolla feeding.

The gross return from sale of milk (at ₹40 per litre) increased markedly from ₹280 per day before Azolla feeding to ₹320 per day after supplementation, reflecting the positive impact of Azolla on milk yield performance. As a result, the net profit per animal per day increased from ₹90 to ₹142, indicating an additional income of ₹52 per animal per day due to Azolla feeding.

Similarly, net profit per litre of milk improved from ₹17.00 to ₹17.26 after Azolla supplementation, highlighting better cost efficiency and higher economic returns. The overall benefit-cost ratio increased significantly from 1.47 under farmers' practice to 1.80 under Azolla supplementation, demonstrating the economic viability and profitability of the technology.

Table 2: Economic Analysis of Azolla Supplementation in Cows: Benefit-Cost Ratio under On Farm Trial

Parameters	Before azolla feeding	After azolla feeding
Feeding cost / day/ animal (Rs.)	190	178
Average feed cost per litre of milk (Rs.)	23	22.7
Gross return from sale of milk (Rs. 40/litre)	280	320
Net profit per day (Rs.)	90	142
Net profit per litre of milk (Rs.)	17	17.30
B:C ratio	1.47	1.8



OFT Impact Statement

The On Farm Trial on Azolla supplementation in lactating cows successfully validated the technology under farmers' field conditions. Azolla feeding resulted in a 9.73 per cent increase in milk yield, while farmers' practice recorded a decline of 8.64 per cent. The intervention reduced feeding cost and enhanced profitability, leading to an additional net income of ₹52 per animal per day and improvement in benefit-cost ratio from 1.47 to 1.80. The technology was found to be technically feasible, economically viable and highly acceptable to dairy farmers.

Conclusion

The On Farm Trial conducted to evaluate Azolla supplementation in lactating cows under farmers' field conditions clearly demonstrated the production and economic advantages of the technology over existing feeding practices. Azolla supplementation resulted in a consistent improvement in milk yield, registering an average increase of 9.73 per cent, whereas a declining trend was observed under farmers' practice. The average milk yield of cows receiving Azolla was higher compared to the control group throughout the trial period.

Economic analysis further revealed that Azolla supplementation reduced feeding cost and increased gross return and net profit. The net profit increased by ₹52 per animal per day and the benefit-cost ratio improved from 1.47 under farmers' practice to 1.80 under Azolla supplementation. The trial confirmed that Azolla is a low-cost, farmer-friendly and sustainable protein supplement that can be easily produced and adopted at the farm level.

Overall, the OFT successfully validated Azolla supplementation as a technically feasible and economically viable feeding intervention for lactating cows under smallholder dairy farming systems.

Recommendations

1. Azolla supplementation @ 1.5-2.0 kg per animal per day may be recommended for lactating cows to improve milk yield and profitability under farmers' field conditions.
2. Azolla cultivation should be promoted at the farm level using low-cost pits or tanks to reduce dependence on costly concentrate feeds.
3. The technology may be scaled up through FLDs, training programmes and demonstrations by KVKs for wider adoption among dairy farmers.
4. Azolla feeding may be integrated with balanced ration advisory programmes to enhance overall feed efficiency and milk productivity.
5. Further studies may be undertaken to evaluate the long-term effects of Azolla supplementation on milk composition and animal health.

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