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An economic analysis of the cost structure of sorghum silage production

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Abstract
The present research "Enrichment of sorghum silage using jaggery and mineral mixture" was conducted at Livestock Department of Animal Husbandry and Dairy science, College of Agriculture, Latur during the year 2022-2023. Total twelve treatments were studied namely T_0 - Control (CSH22SS), T_1- 2% Jaggery + CSH22SS, T_2 - 2% mineral mixture + CSH22SS, T_3 - 2% whey + CSH22SS, T_4 - Control (Dagdi Jowar), T_5-2% Jaggery + Dagdi Jowar, T_6 - 2% mineral mixture + Dagdi Jowar, T_7 - 2% whey + Dagdi Jowar, T_8 - Control (Phule Suchitra), T_9 - 2% Jaggery + Phule Suchitra, T_{10} - 2% mineral mixture + Phule Suchitra, T_{11}- 2% whey + Phule Suchitra respectively. The fodder crop were chaffed into small pieces preferably 2-4 cm length using a chaff cutter. The bags were packed in such a way that neither air enters into the bags nor the gas comes out from the bags. To improve the nutritional quality of ensiling materials (2%) Mineral mixture was evenly sprinkled and thoroughly mixed over the chopped fodders in all treatments. Jaggery (2%) was diluted with water in a 2:1 ratio for easy application. While, whey (2%) was added as an inoculant to improve the fermentation quality. The total cost of silage production for CSH22SS was Rs. 1932 (Rs. 1.93/Kg), Dagdi Jowar was Rs. 1872 (Rs. 1.87/Kg) and for Phule Suchitra it was recorded as Rs. 1912 (Rs. 1.91/Kg). Dagdi Jowar silage recorded the lowest cost (1.87/Kg). while, CSH22SS sorghum silage showed the highest cost (1.93/Kg) and the cost of Phule Suchitra silage (Rs. 1.91/Kg) was found to be intermediate between the two variety silage. Overall, the average cost of silage preparation was about Rs 1.90/kg.

Keywords: Sorghum silage, Jaggery, mineral mixture, whey, cost of structure, economic analysis, statistical analysis

Introduction
Sorghum (*Sorghum bicolor*) is one of the major fodder crops cultivated in the semi-arid regions of India owing to its drought tolerance, adaptability to varied soil types, and high biomass yield. It serves as an important source of green and dry fodder for cattle, buffaloes, sheep, and goats, particularly in rainfed farming systems. Conservation technique that ensures year- round availability of nutritious feed for dairy animals, particularly during periods of green fodder scarcity (Reddy *et al*., 2012) [1]. In Maharashtra, sorghum occupies a prominent place in fodder production and contributes significantly to sustaining livestock-based livelihoods (Patil *et al*., 2018) [4, 6].

The Marathwada region of Maharashtra, including Latur district, is frequently affected by erratic rainfall, recurring droughts, and limited irrigation resources. Under such conditions, sorghum fodder is preferred by farmers due to its lower water requirement and relatively stable yield compared to other fodder crops (ICAR, 2019) [5]. Livestock rearing forms an integral part of the farming system in Latur district, where fodder availability directly influences milk production and farm income.

In India, seasonal variability in fodder production, shrinking grazing lands, and increasing demand for livestock products have highlighted the importance of silage as a strategic feed resource. Sorghum silage plays a vital role in stabilizing milk production and improving feed efficiency during lean seasons. However, the adoption of silage technology largely depends on its economic viability at the farm level.

In recent years, the cost of agricultural inputs such as seed, fertilizers, labor, and irrigation has increased substantially, thereby affecting the economics of fodder cultivation. Estimation of cost of production provides a clear understanding of expenditure incurred at different

stages of cultivation and helps in evaluating the profitability of fodder crops (Kumar *et al*., 2017) [3].

The cost of sorghum silage production comprises several components, including cultivation of sorghum crop, harvesting, chopping, use of additives, labor, transportation, and storage structures such as silage pits or bags. Rising prices of inputs and labor have increased the overall cost of silage production, making it necessary to analyze its cost structure in detail (Singh and Sharma, 2015) [2].

Materials and Methods

1. Location of the research place

The present research "Enrichment of sorghum silage using jaggery and mineral mixture" was conducted at Livestock Department of Animal Husbandry and Dairy science, College of Agriculture, Latur during the year 2022-2023. The livestock farm is located at latur, which is one of 'Marathwada' region in Maharashtra state.

2. Experimental Material

Sorghum fodder (*Sorghum bicolor*) harvested at the flowering stage was used for silage preparation. The harvested fodder was chopped into 2-3 cm lengths using a mechanical chaff cutter. Enrichment materials used in the study included jaggery, mineral mixture, and whey, which are commonly available and economically feasible additives for silage preparation. The additives were applied at predetermined rates (as per standard silage enrichment practices) on a fresh weight basis of sorghum fodder. The enriched fodder was thoroughly mixed, compacted, and ensiled in airtight silage pits/drums to ensure anaerobic conditions. The silage was allowed to ferment for a standard period before opening.

3. Cost Components and Cost Economics

The cost structure of sorghum silage production was worked out by considering both variable and fixed costs incurred during cultivation, silage preparation, and storage. The cost structure of silage was calculated at the end of 60 days of experimental period which was based on cultivation of fodder, harvesting, labour charges and cost production of silage plastic bags at Livestock Farm, College of Agriculture, Latur.

4. Statistical Analysis

The data on the cost structure of sorghum silage prepared using jaggery, mineral mixture, and whey for different sorghum varieties were compiled and tabulated. The analysis was carried out using descriptive statistical methods.

The cost of individual components such as fodder, jaggery, mineral mixture, whey, silage bags, cable ties, labour charges, and transportation charges was calculated on a per-batch basis and expressed in Indian Rupees (₹). The total cost of silage preparation for each sorghum variety was obtained by summing the costs of all input components.

The cost of silage per kilogram (₹/kg) was calculated by dividing the total cost of silage preparation by the total quantity of silage produced. Comparative analysis among sorghum varieties was performed using percentage contribution of each cost component to the total cost to identify major cost-driving factors.

Results and Discussion

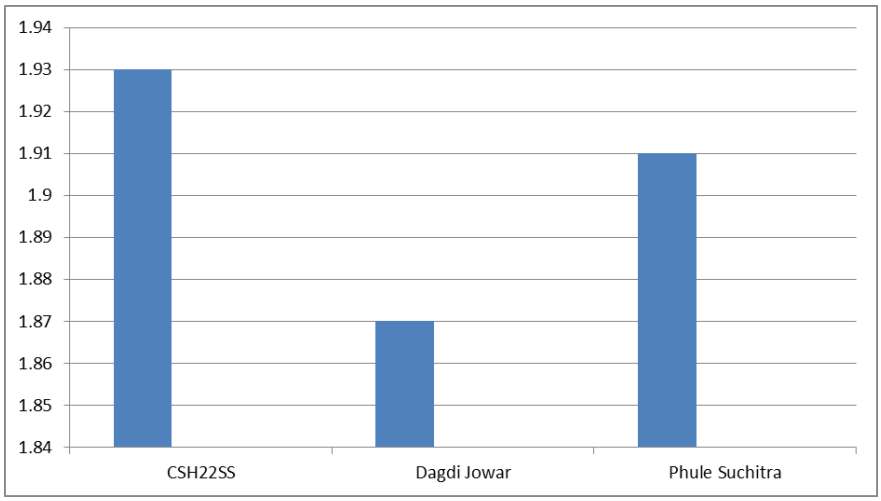
As shown in Table, The cost structure of sorghum silage preparation was worked by considering the expenses on fodder, jaggery, mineral mixture and whey, silage bags, cable ties, labour charges and transportation. The analysis was carried out for three fodder varieties. The total cost of silage production for CSH22SS was Rs. 1932 (Rs. 1.93/Kg), Dagdi Jowar was Rs. 1872 (Rs. 1.87/Kg) and for Phule Suchitra it was recorded as Rs. 1912 (Rs. 1.91/Kg).

Dagdi Jowar silage recorded the lowest cost (1.87/Kg). while, CSH22SS silage showed the highest cost (1.93/Kg) and the cost of Phule Suchitra silage (Rs. 1.91/Kg) was found to be intermediate between the two variety silage. Overall, the average cost of silage preparation was about Rs 1.90/kg.

Cost structure of Sorghum silage by using Jaggery, Mineral mixture and Whey.

Sr. No	Particulars	Sorghum Varieties					
		CSH22SS		Dagdi Jowar		Phule Suchitra	
		Quantity (Kg)	Amount (Kg)	Quantity (Kg)	Amount (Kg)	Quantity (Kg)	Amount (Rs)
1	Fodder cost	20 (Rs. 22/kg)	460	20 (Rs. 20/kg)	400	20 (Rs. 23kg)	440
2	Jaggery	2 (Rs. 28/Kg)	56	2 (Rs. 28/Kg)	56	2 (Rs. 28/Kg)	56
3	Mineral mixture	2	80	2	80	2	80
4	Whey	2 (Rs. 10 kg)	20	2	20	2	20
5	Silage bags	4 (Rs. 50/bag)	200	4	200	4	200
6	Cable tiers	8 (Rs. 2/tier)	16	8	16	8	16
7	Labour charges	2	500	2	500	2	500
8	Transportation charges	-	600	-	600	-	600
9	Total		1,932		1,872		1,912
10	Cost of silage/kg		1.93/kg		1.87/kg		1.91/kg

The findings are in close agreement with Patil *et al*., (2018) [4, 6] reported the cost of sorghum silage production in the range of Rs. 1.80- 2.20kg, when jaggery and whey were used as additive. Similarly, ICAR- NDRI (2019) [5] reported the average cost of sorghum silage in India which is close to Rs. 2.00/kg depending on varieties. Additionally, Singh *et al*., (2022) [7] also founded the sorghum silage cost Rs. 1.85-2.25/kg with 60% fodder cost of total expenditure.



Cost Structure of Sorghum Silage.

Conclusion

The present study on the cost structure of sorghum silage prepared using jaggery, mineral mixture, and whey revealed clear varietal differences in the cost of production. Among the three sorghum varieties evaluated, Dagdi Jowar recorded the lowest total cost of silage production (₹1,872) with a minimum cost of ₹1.87 per kg, followed by Phule Suchitra (₹1,912; ₹1.91 per kg). The highest cost of production was observed in CSH-22SS (₹1,932; ₹1.93 per kg), mainly due to the higher fodder cost.

The major contributors to the total cost were fodder cost, labour charges, and transportation charges, while the expenses on additives such as jaggery, mineral mixture, and whey were comparatively uniform across all varieties. The inclusion of jaggery, mineral mixture, and whey marginally increased the input cost but is justified due to their role in improving silage quality and preservation.

Overall, the study concludes that sorghum silage preparation using these additives is economically feasible, with Dagdi Jowar being the most cost-effective variety. Adoption of this silage preparation method can help farmers reduce feeding costs while ensuring year-round availability of nutritious fodder, thereby improving livestock productivity and farm profitability.

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