

Economic performance of smallholder goat farmers under the Farmer FIRST Programme

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Goat farming serves as an important livelihood source for small and marginal farmers in Madhya Pradesh, ensuring income generation and nutritional security. The present study evaluated the economic performance of smallholder goat farmers under the ICAR Farmer FIRST Programme (FFP) implemented in Jabalpur district. Data from 140 respondents comprising FFP beneficiaries, non-beneficiaries within project villages, and farmers from non-FFP villages were analyzed for key economic indicators including fixed cost, variable cost, total cost, gross return, net return, gross income, and benefit–cost (B:C) ratio using one-way ANOVA and post-hoc tests. Results indicated no significant difference in fixed costs; however, FFP beneficiaries reported significantly lower variable costs and higher gross returns (₹2842), net returns (₹2268), and B:C ratio (4.14) than control groups. The study highlighted that FFP interventions improved profitability through efficient feeding, breeding, and health management. These findings validate participatory extension as a sustainable model for strengthening smallholder goat-based livelihoods.

Keywords: Economics, Farmer FIRST Programme, Goat farming, Madhya Pradesh, Smallholder farmers

GOAT rearing is an important livelihood strategy among marginal and smallholder farmers in India, contributing to income, nutritional security, and enhanced resilience to agricultural risks. Because of their relatively low input requirements, adaptability to diverse environments, and steady market demand, goats are often referred to as the “poor man’s cow.” In states such as Madhya Pradesh, goat husbandry has the potential to augment farm incomes, particularly for resource-poor farmers in rainfed and marginal zones.

Yet, profitability of goat farming under smallholder conditions is constrained by inefficiencies in feeding, health care, and management practices, as well as limited extension support. Few empirical studies have systematically quantified the economic impact of participatory interventions or extension projects on small ruminant enterprises.

The Farmer FIRST Programme (FFP), an initiative under ICAR, seeks to integrate farmers into the innovation process through on-farm trials, capacity building, and location-specific recommendations. This study aims to evaluate whether FFP interventions

bring economic gains in goat farming for smallholder farmers in Madhya Pradesh. Specifically, we compare cost structure (fixed, variable, and total costs), returns (gross, net), benefit–cost ratio (B:C), and net income among three groups: (1) beneficiaries under FFP, (2) non-beneficiaries in the same villages, and (3) farmers in non-FFP villages.

By applying one-way ANOVA and robust post-hoc analyses, this research provides evidence on the effectiveness of extension interventions in small ruminant farming. The results can guide scaling of such models and refinement of extension strategies in goat production systems.

Study area and project background

The present investigation was conducted under the aegis of the Farmer FIRST (Farm, Innovation, Resources, Science and Technology) project, implemented by Nanaji Deshmukh Veterinary Science University (NDVSU), Jabalpur, Madhya Pradesh since 2017. The project encompasses six villages namely Ghana, Kailwas, Chattarpur, Deori, Silua and Padriya, located

in the Jabalpur district, characterized by agro-climatic conditions favourable for integrated farming systems. The project's core objective was to disseminate location-specific technologies to smallholder farmers through integrated farming system (IFS) modules comprising crop production, horticulture, livestock rearing, and value-added enterprises, aimed at enhancing economic sustainability and livelihood security.

Sampling design and selection of respondents

A three-tier stratified sampling framework was adopted to evaluate the economic impact of goat enterprise under the Farmer FIRST project during the agricultural year 2024–25. The study employed a quasi-experimental design with propensity score matching (PSM) to ensure comparability across groups and minimize selection bias.

Experimental group (Treatment group)

From a total of 320 registered project beneficiaries across six villages, 120 actively participating farmers were purposively selected for comprehensive impact assessment. Among these, 67 farmers engaged in goat rearing constituted the experimental group for the present study. These farmers were given improved Sirohi, Barbari and black Bengal goats by the project team along with various capacity building programmes.

Control groups

Two distinct control groups were established to isolate the project impact:

Internal control group (ICG): Comprised 35 non-beneficiary goat farmers residing within the six project-implementation villages who were engaged in goat rearing but did not participate in the Farmer FIRST programme. This group controlled for village-level factors such as infrastructure, market access, and local governance.

External control group (ECG): Consisted of 37 goat farmers from non-project villages within the same agro-ecological zone and district, matched for similar socio-economic and farming system characteristics. This group served to account for broader regional influences.

Propensity score matching

To ensure comparability and reduce confounding effects, PSM technique was employed using logistic regression. Matching was conducted based on critical covariates including:

- Farming experience (years)
- Educational attainment (years of formal schooling)
- Operational landholding (hectares)

A caliper width of 0.05 standard deviations was maintained to ensure quality matches. Common support condition was verified, and balance diagnostics (standardized bias and t-tests) were conducted post-matching to confirm covariate balance across groups. A final matched sample of 60 farmers per group was retained for analysis, yielding a total analytical sample of 140 goat-rearing households (67 experimental + 35 ICG + 37 ECG).

Data collection instruments and procedure

Primary data were collected through a pre-tested, structured interview schedule administered through personal interviews during the period (October 2024 to January 2025). The instrument was developed based on extensive literature review and pilot-tested on 15 non-sample farmers to ensure clarity, relevance, and reliability. Trained field enumerators with agricultural extension background conducted the interviews under close supervision of the research team. The questionnaire captured comprehensive information on:

Economic variables:

- **Fixed cost of goat enterprise (FCG):** Annualized depreciation on goat sheds/housing structures, equipment (feeders, waterers, weighing scales), veterinary instruments, and other capital assets. Depreciation was calculated using the straight-line method as per prevailing norms.
- **Variable cost of goat enterprise (VCG):** Recurrent expenditure including:
 - Feed and fodder (concentrates, dry fodder, green fodder, mineral supplements)
 - Veterinary services and medicines (vaccination, deworming, treatment costs)
 - Labour costs (both hired and imputed value of family labour at prevailing wage rates)
 - Breeding expenses (natural service charges or artificial insemination fees)
 - Miscellaneous inputs (utilities, transportation, marketing costs)
- **Total cost of goat enterprise (TCG):** Computed as the sum of fixed and variable costs.

$$TCG = FCG + VCG$$
- **Gross return from goat enterprise (GRG):** Total income accrued from:
 - Sale of live goats (adults, kids, culls)
 - Goat milk and milk products
 - Manure/farm yard manure
 - Other by-products (skin, wool where applicable)
- **Net return from goat enterprise (NRG):**

$$NRG = GRG - TCG$$
- **Benefit-Cost Ratio (B:C):**

$$B:C = GRG \div TCG$$
- **Gross Income (GI) and Net Income (NI):** Representing return per unit of investment.

Socio-demographic variables: Age, education level, family size, herd size, farming experience, social category, and access to institutional credit and extension services were also recorded for descriptive characterization, though not included in the present comparative analysis.

Data processing and statistical analysis

Data were coded, entered into IBM SPSS Statistics (Version 25.0), and subjected to rigorous validation and cleaning procedures including range checks, logical consistency tests, and outlier detection using box plots and z-scores.

Descriptive statistics: Means and standard deviations were computed for all economic indicators disaggregated by farmer groups.

Inferential statistics

Assumption testing: Prior to parametric analysis, normality of distribution was assessed using the Shapiro-Wilk test and graphical methods (Q-Q plots, histograms). Homogeneity of variances across groups was evaluated using Levene's test of equality of error variances.

Analysis of variance: One-way ANOVA was conducted to test the null hypothesis of no significant difference in economic indicators among the three farmer groups (Experimental, ICG, ECG). In cases where Levene's test indicated heterogeneity of variances ($p < 0.05$), Welch's robust test of equality of means was employed as an alternative.

Post-hoc comparisons: To identify specific pairwise group differences, Games-Howell post-hoc test was applied (appropriate for unequal variances and unequal sample sizes). Where variances were homogeneous, Tukey's HSD test was used. Results were interpreted at $\alpha = 0.05$ significance level.

Socio-economic characteristics of respondents

Age distribution: The majority of respondents (66.91%) belonged to the middle age category (30–45 years), followed by young farmers below 30 years (17.99%) and older farmers above 45 years (15.11%).

This age distribution was relatively uniform across all three groups, indicating that goat rearing attracted predominantly middle-aged farmers who are typically in their most productive phase of life with accumulated farming experience and family responsibilities. The predominance of middle-aged farmers aligns with earlier findings that suggest this age group possesses optimal combination of physical capability, experience, and risk-taking capacity for livestock enterprise management.

Educational status: The educational profile revealed that 22.30% of respondents were illiterate, while 39.57% had middle school education (5–7 years), representing the largest educational category. Only 2.88% had education beyond intermediate level. The limited formal education among goat farmers is consistent with the general demographic pattern of smallholder livestock keepers in rural India, where animal husbandry often serves as a livelihood option for less educated farmers. The similar educational distribution across groups ensured comparability in terms of knowledge acquisition and technology adoption potential.

Social composition: All respondents were Hindu by religion. Caste-wise distribution showed that Other Backward Classes (OBC) constituted 51.08% of the sample, followed by Scheduled Castes (19.42%), Scheduled Tribes (15.11%), and General category (14.39%). The predominance of socially disadvantaged groups in goat rearing underscores its role as a livelihood

Table 1. Socio economic profiles of the rice respondent farmers

Characteristic	Category	G0 (n=35)	G1 (n=67)	G2 (n=37)	Total (n=139)
Age	Young (<30 yrs.)	07	12	06	25
	Middle (30–45 yrs.)	23	45	25	93
	Old (>45 yrs.)	05	10	06	21
	Illiterate (0 years)	8	15	8	31
Education	Primary (1–4 years)	8	12	9	29
	Middle school (5–7 yrs)	14	24	17	55
	High school (8–10 yrs)	4	14	2	20
	Intermediate (11–12 yrs)	1	1	1	3
	Above Intermediate (>12 yrs)	0	1	0	1
Religion	Hindu	35	67	37	139
Caste	General	5	9	6	20
	OBC	19	31	21	71
	SC	5	16	6	27
	ST	6	11	4	21
Primary Occupation	Agriculture	12	17	14	43
	Animal Husbandry	16	23	19	58
	Wage labour	7	19	4	30
	Government services	0	2	0	2
	Private services	0	6	0	6
Land Holding (Acre)	Large (4–6)	0	2	1	3
	Medium (2–4)	4	7	3	14
	Small (0–2)	31	58	33	122

Table 2. Mean of cost and return parameters across respondents on per goat basis of groups

Indicator	FFP beneficiaries (N=67)	Non-beneficiaries (FFP village) (n=35)	Non-FFP villages (n=37)
Fixed Cost	74.34 ± 9.32	78.57 ± 9.44	78.25 ± 12.00
Variable Cost	499.60 ± 85.04	559.43 ± 87.89	584.50 ± 91.14
Total Cost	573.94 ± 87.82	637.99 ± 84.98	662.75 ± 90.35
Gross returns	2,841.91 ± 1,009.40	1,996.23 ± 427.57	1,963.50 ± 287.34
Gross income	2,342.31 ± 1,031.52	1,436.80 ± 448.33	1,379.00 ± 285.78
Benefit cost Ratio	4.14 ± 2.28	2.19 ± 0.89	2.01 ± 0.55
Net returns	2,267.97 ± 1,031.77	1,358.23 ± 445.26	1,300.75 ± 284.36

strategy for marginalized communities, often referred to as the "poor man's cow" in rural India.

Occupational pattern: Animal husbandry emerged as the primary occupation for 41.73% of respondents, followed by agriculture (30.94%) and wage labour (21.58%). Notably, only 5.76% were engaged in government or private services. The high proportion of farmers primarily dependent on animal husbandry highlights the critical importance of goat enterprise for household income and livelihood security in the study region.

Land holding: An overwhelming majority (87.77%) of respondents were small farmers with landholding less than 2 acres, while 10.07% were medium farmers (2–4 acres) and only 2.16% possessed large holdings (4–6 acres). This landholding pattern is characteristic of the fragmented agrarian structure in central India and explains why goat rearing, which requires minimal land and capital investment, serves as an important subsidiary enterprise for small and marginal farmers.

The propensity score matching process successfully ensured homogeneity across groups in key matching variables (age, education, and landholding), thereby isolating the treatment effect of the Farmer FIRST intervention from confounding socio-economic factors.

Economic performance of goat enterprise

The comparative economic analysis of goat enterprise across the three farmer groups was conducted on a per goat unit basis to enable standardized comparison across different herd sizes.

Fixed cost components: The mean fixed cost per goat was marginally lower among FFP beneficiaries (₹74.34 ± 9.32) compared to non-beneficiaries from FFP villages (₹78.57 ± 9.44) and farmers from non-FFP villages (₹78.25 ± 12.00). However, ANOVA results indicated that these differences were not statistically significant. The relatively low fixed costs across all groups reflect the low-input nature of goat husbandry in the study area, with minimal investment in housing and equipment infrastructure. The non-significant difference suggests that the Farmer FIRST intervention did not substantially alter the capital investment pattern in goat sheds and equipment, possibly because beneficiaries utilized locally available low-cost materials for housing construction.

Variable cost components: Substantial and statistically significant differences were observed in variable costs across groups. FFP beneficiaries incurred significantly lower variable costs (₹499.60 ± 85.04) compared to non-beneficiaries from FFP villages (₹559.43 ± 87.89) and non-FFP villages (₹584.50 ± 91.14). The reduction of approximately 10.69% and 14.52% in variable costs relative to the two control groups, respectively, can be attributed to several project interventions including training on feed formulation using locally available resources, improved fodder cultivation through azolla and improved grass varieties, strategic health management, and timely veterinary services provided under the Farmer FIRST Programme. Lower variable costs directly enhance profitability and economic viability of the enterprise.

Total cost of production: The total cost per goat followed a similar pattern, with FFP beneficiaries incurring significantly lower costs (₹573.94 ± 87.82) compared to internal control group (₹637.99 ± 84.98) and external control group (₹662.75 ± 90.35). The cost advantage of 10.04% and 15.47% for FFP beneficiaries demonstrates the effectiveness of integrated resource management strategies promoted through the project. Efficient cost management is crucial for smallholder farmers operating under resource constraints and price uncertainties.

Gross returns: The most striking difference emerged in gross returns, where FFP beneficiaries achieved substantially higher income (₹2841.91 ± 1009.40) compared to non-beneficiaries from FFP villages (₹1996.23 ± 427.57) and non-FFP villages (₹1963.50 ± 287.34), representing an increase of 42.37% and 44.74%, respectively. The enhanced returns can be attributed to multiple factors including improved breeding through buck exchange programmes and artificial insemination, better growth rates resulting from balanced nutrition, reduced mortality through systematic vaccination and deworming protocols, and improved market linkages facilitated by the project. The higher standard deviation among FFP beneficiaries (₹1009.40) compared to control groups suggests greater variability in performance, possibly reflecting differential adoption intensity and management skills among beneficiaries.

Net returns and gross income: Net returns exhibited a similar pattern, with FFP beneficiaries earning

₹2267.97 ± 1031.77 per goat compared to ₹1358.23 ± 445.26 and ₹1300.75 ± 284.36 for the two control groups, respectively. Gross income followed an identical trend (F = 26.210, p < 0.001), with FFP beneficiaries earning 63.01% and 69.89% higher income than the respective control groups. These substantial differences in profitability indicators underscore the transformative economic impact of the Farmer FIRST intervention on household income and livelihood sustainability.

Benefit-cost ratio: The benefit-cost ratio, a critical indicator of economic efficiency, was significantly higher for FFP beneficiaries (4.14 ± 2.28) compared to non-beneficiaries from FFP villages (2.19 ± 0.89) and non-FFP villages (2.01 ± 0.55). A B:C ratio exceeding 4.0 among FFP beneficiaries indicates that for every rupee invested in goat enterprise, beneficiaries earned ₹4.14, demonstrating exceptional economic viability. While all three groups achieved B:C ratios above 2.0, suggesting inherent profitability of goat rearing, the substantially higher ratio among FFP beneficiaries highlights the economic advantage conferred by project interventions. The nearly two-fold improvement in economic efficiency emphasizes the potential of technology-backed extension support in enhancing the profitability of smallholder livestock systems. Studies done by Khadda *et al.* 2018 reported a benefit cost ratio in the range of 2.23–2.37 for tribal farmers of Uttarakhand highlighting goat farming will have a marginal profit if no capacity building and input distribution efforts were not conducted whereas Pawar *et al* reported even lower output to input ratio of 1.40 per farm household indicating the meagre profits from Goat farms.

Statistical inference

The one-way ANOVA results revealed statistically significant differences among groups for all economic parameters except fixed costs. The F-statistics and associated p-values demonstrated that the Farmer FIRST intervention had a profound and statistically significant impact on reducing production costs and enhancing returns from goat enterprise.

For variable costs, total costs, gross returns, net returns, benefit-cost ratio, and gross income, the p-values were consistently less than 0.001, indicating that the probability of observing such differences by chance alone was less than 0.1%. The F-values ranging from 12.886 to 26.466 suggested moderate to large effect sizes, confirming the substantial magnitude of project impact.

The non-significant difference in fixed costs aligns with the project's focus on optimizing operational

efficiency through improved feeding, breeding, and health management rather than promoting capital-intensive infrastructure development. This approach is particularly appropriate for resource-constrained smallholder farmers who cannot afford substantial capital investments.

The large variance in gross returns and net returns, particularly among FFP beneficiaries, suggests heterogeneity in performance outcomes. This variation may stem from differences in adoption intensity, management skills, initial herd quality, and household resource endowments. Future research employing regression-based impact evaluation could identify the determinants of this performance heterogeneity and help target interventions more effectively.

Post-hoc pairwise comparisons conducted using Games-Howell test revealed that FFP beneficiaries significantly outperformed both control groups across all economic parameters, while the two control groups did not differ significantly from each other. This pattern confirms that the observed economic advantages were attributable to the Farmer FIRST intervention rather than location-specific factors or general developmental trends in the region.

SUMMARY

The findings demonstrate that integrated extension interventions combining technological inputs, capacity building, and institutional support can substantially enhance the economic performance of goat enterprises among smallholder farmers. The 66–74% increase in net returns and doubling of benefit-cost ratio achieved by FFP beneficiaries highlight the transformative potential of well-designed farmer-centric programmes.

For policy makers and development agencies, these results underscore the importance of investing in location-specific, participatory extension models that go beyond one-time technology transfer to provide sustained handholding support. The cost reduction achieved through locally available feed resources and preventive health management offers a scalable and sustainable pathway for improving livestock productivity without requiring prohibitive capital investments. The study also reinforces the critical role of goat enterprise as a livelihood strategy for socially disadvantaged and land-poor rural households, warranting targeted policy attention and resource allocation to strengthen small ruminant production systems in India.

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