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Minor Irrigation and Economic Upliftment: A study on Tribal Farming Households in Sambalpur District

Rasan Bhengra[1], Dr Sanjeeta Kumari Devi[2]

[1]Ph.D. Research Scholar, KISS DU, Bhubaneswar (ORCID ID – 0009-0008-3173-2649)
[2]Assistant Professor in Economics, KISS DU, Bhubaneswar (ORCID ID – 0000-0003-2580-3048)

Corresponding Author: Rasan Bhengra

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ABSTRACT

This abstract explores the transformative role of minor irrigation projects in enhancing the livelihoods of tribal farmers, using primary data collected from selected villages across Sambalpur district, Odisha. The research examines changes in income levels, cropping patterns, agricultural productivity, and employment opportunities before and after the implementation of the minor irrigation scheme. Quantitative (statistical analysis of paired T – test, trends and patterns in implementation and outcomes) methods. The findings reveal that assured water availability has significantly increased agricultural output, encouraged crop diversification, and reduced dependence on rain-fed farming. Tribal households experienced notable improvements in farm income, food security, and engagement in allied activities such as fisheries and vegetable cultivation. Overall, the study highlights minor irrigation as a key driver of rural economic upliftment and a catalyst for sustainable development among tribal communities.

Keywords: Irrigation, Farmer, agricultural productivity, income level, cropping pattern

1. INTRODUCTION

Agriculture continues to be the backbone of rural India, particularly for tribal farming communities who depend overwhelmingly on subsistence farming for their livelihood. In regions such as Odisha's Sambalpur district, where tribal households predominantly engage in agriculture, the sector is largely rain-fed and vulnerable to climatic variability. Limited access to reliable irrigation infrastructure has historically constrained agricultural productivity, leaving these households exposed to the vagaries of monsoon patterns and low crop yields. Minor irrigation interventions — including farm ponds, check dams, tube wells, dug wells, and lift irrigation systems — are thus recognised as crucial tools for enhancing water availability for crops and enabling year-round agricultural activities. (Ministry of Tribal Affairs).

Minor irrigation plays a vital role in tribal landscapes due to its adaptability to local terrain and cost-effectiveness relative to major irrigation projects. By providing assured water supply, even on a small scale, these systems reduce dependence on rain-fed agriculture, increase cropping intensity, and promote crop diversification into high-value and rabi season crops. Studies from other tribal areas in Odisha have shown that improved water management and minor irrigation can transform agricultural practices, boosting yields and enabling farmers to diversify into vegetables and allied activities such as pisciculture, thereby significantly raising household incomes.

(Indian Council of Agricultural Research). Empirical evidence also highlights the wider socioeconomic benefits of minor irrigation interventions. Research on micro irrigation projects executed in tribal regions of Odisha under the Tribal Sub Plan revealed positive impacts on productivity, employment generation, input use efficiency, and farm income among tribal beneficiaries. These projects — encompassing structures such as diversion weirs, water harvesting systems, and shallow tube wells — not only enhanced the irrigation potential of previously rain-dependent areas but also contributed to improving the overall socioeconomic status of tribal farming families. (Ministry of Tribal Affairs).

By ensuring more stable water supply, minor irrigation reduces crop failure risk, fosters agricultural intensification, and promotes diversified livelihood opportunities. These factors collectively support economic upliftment by increasing agricultural revenues, generating off-farm employment opportunities, and enhancing food and nutritional security. In the context of Sambalpur district, evaluating how minor irrigation augments incomes and livelihoods among tribal farming households can offer valuable insights for policymakers and development practitioners aiming to design inclusive rural development strategies.

Agriculture remains the primary source of livelihood for tribal farming households in Odisha, particularly in districts like Sambalpur, where a significant proportion of the population depends on rain-fed cultivation. Despite possessing rich natural resources, tribal farmers often face persistent challenges such as erratic rainfall, small and fragmented landholdings, low agricultural productivity, and limited access to modern irrigation facilities. These constraints adversely affect farm incomes, employment opportunities, and overall economic well-being, thereby reinforcing cycles of poverty and vulnerability.

2. REVIEW OF LITERATURE

Gebrehiwot et al. (2017) investigated the use of an endogenous switching regression model to measure the impact of participation in micro-irrigation development on households' welfare, taking into account selection bias associated with programme participation and endogeneity problems often encountered in most programme evaluations.

Khan et al. (2018) highlight the impact of the Gomal Zam Dam (GZD) irrigation project on agriculture and the welfare of farm households in the Southern districts of Khyber Pakhtunkhwa, Pakistan.

Mukherji et al. (2002) analysed by authors of conducted a case study in a tribal dominated block of Gujarat and found that the success of these two schemes lies in the creation of Pingot LBMC society, where tribal farmers came forward on their own and formed an irrigation society to take over management of the canal system.

Prathapachandran & Devadas (2023) explored that in rural Wayanad, Kerala, India, explores sustainable traditional farming practices to boost income growth and productivity among tribal households, revealing that mixed farming methods are more profitable and income levels influence the adoption of advanced technologies.

Verma et al. (2002) highlight that minor irrigation has significantly uplifted tribal farming households in South Gujarat by increasing crop yields, enhancing cropping intensity, and reducing out-migration. The transition from local paddy to hybrid paddy and irrigated groundnut or moong has improved livelihoods. However, non-tribal farmers benefited more from Participatory Irrigation Management (PIM) due to lucrative sugarcane farming. The success of PIM in tribal areas underscores the importance of profitability in sustaining irrigation initiatives and encouraging shifts to more profitable crops.

Yihdego et al., (2015) explored the impact of small-scale irrigation on income of rural farm households using Heckman treatment effect two-step model and found that household head with social leadership, access to extension, and availability of irrigable land, number of oxen and family size have

significant and positive effect whereas the family size square and distant to the nearest market restrains participation in small scale irrigation.

OBJECTIVE

1. To study the impact of minor irrigation on the agricultural productivity of tribal farming households.
2. To assess changes in the income and employment of tribal farmers after the introduction of minor irrigation.

3. METHODOLOGY

3.1 Study area

The study area, encompassing the blocks of Jujomura and Jamankira in Sambalpur district of Odisha, presents a diverse demographic structure. These regions are predominantly rural and inhabited by a significant proportion of Scheduled Tribes (STs), who rely mainly on agriculture, forest produce, and wage labour for their livelihood. The study adopts a descriptive-analytical research design to examine the role of minor irrigation in improving the livelihood security and economic upliftment of tribal farming households. The study was conducted in tribal-dominated villages of Sambalpur district. where minor irrigation projects have been implemented. The area was purposively selected due to the significant presence of tribal farming households and the operational status of minor irrigation schemes.

3.2 Sampling Technique and Sample Size

A multistage sampling technique was used. In the first stage, villages covered by minor irrigation projects were purposively selected. In the second stage, tribal farming households were selected using random sampling. A total of 399 sample households were surveyed for the study.

3.3 Sources of Data

Primary data

Primary data were collected through a structured household survey and interview with tribal farmers in Jujomura and Jamankira blocks. The survey focuses on

- **Land use pattern:** Land allocation by tribal population for various purposes, and is shaped by geography, population, culture, etc
- **Cropping pattern:** how tribal farmers are arranging different crops grown in a specific area over time, determined by climate, soil, and resources, aiming to maximise land use.
- **Income level:** What is the amount of money an individual or household earns through Minor irrigation
- **Employment opportunity:** whether the Minor irrigation creates new employment opportunities or reduces employment creation
- **Livelihood conditions before and after minor irrigation:** Economic condition of the household can be identified in the study area by pre- and post-minor irrigation

Secondary Data

The study also relies on secondary data sources to supplement primary findings and a broader perspective. The secondary data was collected from government reports, irrigation department records, census data, research articles, and published studies.

3.4 Use of SPSS Software for Data Interpretation

The collected data will be analysing using SPSS software. Which allows for

Regression analysis: Estimating the impact of various minor irrigation schemes on agricultural productivity. Regression Analysis → Applied to assess the impact of access to MIPs on household income while controlling for other factors like landholding size, education, and credit access. The regression model may be expressed as:

$Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\cdots+\epsilon$

Where:

Y = Household income (dependent variable)

X_1= Access to MIP

X_2= Landholding size

X_3= Education level

X_4= Access to credit
ϵ = Error term

4. RESULTS AND ANALYSIS

This section presents the results of the study, highlights trends in agricultural productivity, and the access to minor irrigation to farm output and other factors affecting income productivity. The analysis is based on manipulated data, considering different variables influencing agricultural growth.

Descriptive statistics were used to summarize and describe the socio-economic characteristics of tribal farming households and key variables related to minor irrigation and economic upliftment. Measures such as mean, standard deviation, minimum, and maximum values were computed to understand the central tendency and variability of the data.

Table 1: Descriptive Statistics of Socio-Economic and Irrigation-Related Variables

Age of Household Head (Years)	22	72	44.36	10.87
Family Size (Number)	2	9	5.12	1.63
Land Holding (Hectares)	0.25	3.5	1.18	0.74
Irrigated Area (Hectares)	0	2.8	0.89	0.68
Annual Agricultural Income (₹)	28,000	1,85,000	76,540	32,410
Cropping Intensity (%)	90	185	142.6	21.3
Employment Days per Year	140	310	224.8	36.5

Source: Computed by excel

Table 1. shows descriptive analysis that household heads are mostly in their economically active age group, with moderately large family sizes typical of tribal communities. Small and marginal landholdings dominate the study area, and access to irrigation remains partial, underlining the significance of minor irrigation projects. Agricultural income varies widely among households, while higher cropping intensity indicates better land use due to irrigation. Increased employment days further demonstrate the positive role of minor irrigation in improving livelihood security among tribal farming households.

Table 2: Distribution of Households by Access to Minor Irrigation

Access to Irrigation	Frequency	Percentage
Access to Minor Irrigation	238	59.6
No Access to Irrigation	161	40.4
Total	399	100

Computed by excel

Table 2. illustrate tribal farming households, 59.6% had access to minor irrigation, while 40.4% were still dependent on rain-fed agriculture. This indicates a significant but incomplete coverage of irrigation facilities in Sambalpur district, leaving scope for policy intervention and infrastructure expansion.

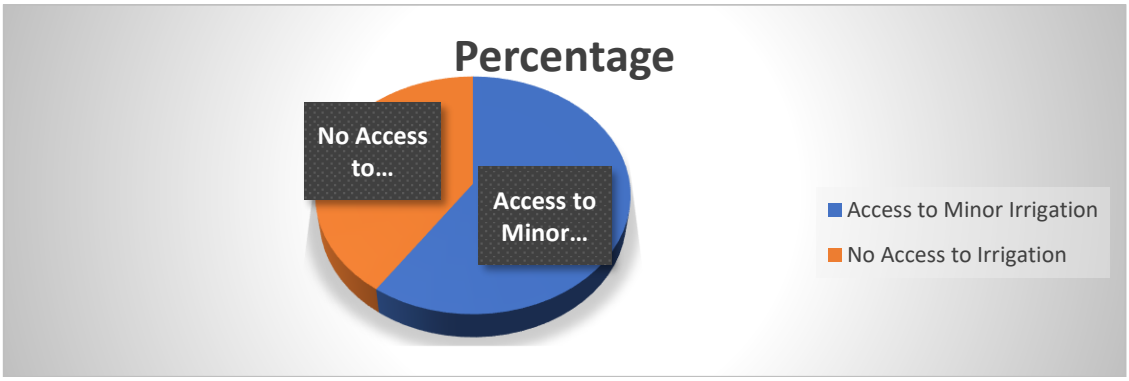

Table 3: Descriptive Statistics of Economic Upliftment Indicators

Indicator	Minimum	Maximum	Mean	Std. Deviation
Crop Productivity Index	32	88	61.4	12.6
Income Stability Index	28	85	58.7	13.2
Asset Creation Index	15	72	44.9	14.8
Overall Economic Upliftment Index	30	81	55.6	11.9

Computed by excel

Table 3. illustrate the mean economic upliftment index score of 55.6 indicates a moderate level of economic improvement among tribal households. Higher scores in crop productivity and income stability suggest that minor irrigation has contributed positively to agricultural performance and income security.

4.1 Regression Analysis

Table 4: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.682	0.465	0.458	6.94

Computed by Author using SPSS

The value of R = 0.682 indicates a strong positive relationship between the dependent and independent variables. The R-squared value of 0.465 indicates that 46.5% of the variation in the economic upliftment of tribal households is explained by the selected independent variables. The adjusted R-squared (0.458) confirms the robustness of the model after adjusting for the number of predictors

Model	Unstandardized B	Std. Error	Standardized Beta	t	Sig.
(Constant)	21.45	2.31	—	9.28	0
Access to Minor Irrigation	6.82	0.94	0.38	7.26	0
Landholding Size	2.15	0.63	0.17	3.41	0.001
Irrigated Area	3.74	0.81	0.26	4.62	0
Cropping Intensity	0.09	0.02	0.22	4.5	0
Employment Days	0.04	0.01	0.19	3.98	0

Computed by Author using SPSS

Access to minor irrigation has a positive and highly significant impact on economic upliftment ($\beta = 0.38$, $p < 0.01$), indicating that households with irrigation facilities are economically better off than rain-fed households. Landholding size and irrigated area also show significant positive effects, confirming that resource availability enhances economic outcomes.

Cropping intensity has a positive and significant coefficient, suggesting that efficient land use enabled by irrigation contributes to higher economic upliftment. Employment days also exert a significant positive influence, reflecting the role of irrigation in generating additional on-farm employment.

5. CONCLUSION

The present study examined the role of minor irrigation in the economic upliftment of tribal farming households in Sambalpur district. The findings clearly establish that access to minor irrigation has a significant and positive impact on agricultural productivity, income generation, employment opportunities, and overall livelihood security of tribal households.

The descriptive analysis revealed that the majority of households are small and marginal farmers with partial access to irrigation facilities. Despite limited landholdings, households with access to minor irrigation demonstrated higher cropping intensity, increased employment days, and better income levels compared to rain-fed households. This highlights the

crucial role of minor irrigation in optimizing land use and reducing dependence on monsoon rainfall.

The regression analysis further confirmed that access to minor irrigation is one of the most influential determinants of economic upliftment. Variables such as irrigated area, landholding size, cropping intensity, and employment generation showed statistically significant positive relationships with the economic upliftment index. The model explained a substantial proportion of variation in economic outcomes, underscoring the effectiveness of minor irrigation as a tool for rural economic development.

Overall, the study concludes that minor irrigation projects serve as a vital intervention for improving the socio-economic conditions of tribal farming communities in Sambalpur district. Strengthening and expanding minor irrigation infrastructure, along with ensuring equitable access and efficient management, can significantly enhance agricultural sustainability, reduce poverty, and promote inclusive growth among tribal households. The findings of this study provide valuable insights for policymakers and development agencies in designing targeted irrigation-based development strategies for tribal and rain-fed regions.

Declaration by Authors

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