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Zero Budget Natural Farming Impact on Tribal *Rabi* Rice Farming: Economic Analysis

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study examines the economic viability of implementing Zero Budget Natural Farming (ZBNF) interventions in *rabi* rice cultivation, focusing on cost-effectiveness and productivity outcomes. Data collected before (2014-15) and after (2018-19) ZBNF adoption in a selected tribal area of Visakhapatnam district of Andhra Pradesh, India were analysed. Results reveal a reduction in total variable costs by 10.20 per cent, primarily attributed to decreases in weeding and nutrient supply expenses. Despite a slight increase in operational costs, ZBNF led to a significant drop (51.30 per cent) in input expenditures. Yield experienced a notable 10.25 per cent increase, resulting in a decrease in production costs from ₹1161.23 to ₹934.34 per quintal. The calculated cost-to-benefit ratio of -1:1.17 demonstrates favourable economic outcomes, highlighting the potential of ZBNF to enhance economic viability and sustainability in *rabi* rice cultivation among tribal farmers.

Keywords: Cost-effectiveness; economic viability; interventions; rice and ZBNF.

1. INTRODUCTION

Agriculture has long been the backbone of India's economy, with milestones like the Green Revolution in the 1960s and economic liberalization in the 1990s propelling the nation from food scarcity to surplus. However, conventional agricultural practices have taken a toll on soil and human health, with over 50% of consumables containing carcinogenic chemicals, as noted by the World Health Organization (WHO). Present-day agriculture faces a myriad of challenges, including high cultivation costs, prolonged dry spells, crop failures, groundwater depletion, and environmental degradation. These issues extend to food scarcity, chemical residues, nutrient deficiencies, and health hazards. Soil erosion, reduced water retention capacity, and declining biodiversity further exacerbate the challenges, while climate change and global warming pose additional threats [1,2,3,4,5,6]. The Food and Agricultural Organization (FAO) has warned of dwindling harvest years if these trends persist.

However, nature offers solutions through low-input farming practices, which promise reduced costs, increased yields, and improved soil fertility. Zero Budget Natural Farming (ZBNF) is one such approach, rooted in agro-ecology and pioneered by Japanese scientist Masanobu Fukuoka, and later adapted by Subhash Palekar in India during the 1990s [7-10]. ZBNF emphasizes farming in harmony with nature, eschewing synthetic fertilizers and pesticides [11]. The term "Zero Budget" signifies farming without external credit or expenses, with income from main crops offsetting costs of short-duration intercrops [12]. Central to ZBNF are its four pillars: Beejamrutham for disease prevention, Jeevamrutham to enhance soil microbes, Acchadana/Mulching for water retention and weed control, and Waaphasa/Moisture for drought resilience and water efficiency. Insect and pest management in ZBNF relies on natural decoctions made from cow urine, dung, garlic, and green chilies [13,14]. By promoting sustainable practices and minimizing reliance on external inputs, ZBNF offers a promising alternative for farmers seeking to improve yields, protect soil health, and provide chemical free food for consumers [15,16]. In recent years, ZBNF has gained significant attention as a viable alternative to conventional farming methods, particularly in regions grappling with environmental degradation and economic instability.

Rice cultivation, particularly in the *rabi* season, presents unique challenges and opportunities for farmers. The adoption of ZBNF principles in *rabi* rice cultivation has garnered interest due to its potential to improve economic viability, reduce dependency on external inputs, and enhance environmental sustainability. Understanding the economic implications of implementing ZBNF interventions in *rabi* rice farming is crucial for informed decision-making by farmers, policy makers, and agricultural stakeholders [17-20].

In this context, this study investigates the economic viability of different farm interventions associated with ZBNF in *rabi* rice cultivation. It examines the cost-effectiveness and productivity outcomes of transitioning from conventional methods to ZBNF practices, focusing on factors such as cost reduction, yield improvement, and overall profitability. By analysing the impact of ZBNF interventions on production costs, yields, and net returns, this research contributes valuable insights into the economic feasibility and potential benefits of ZBNF adoption in rice

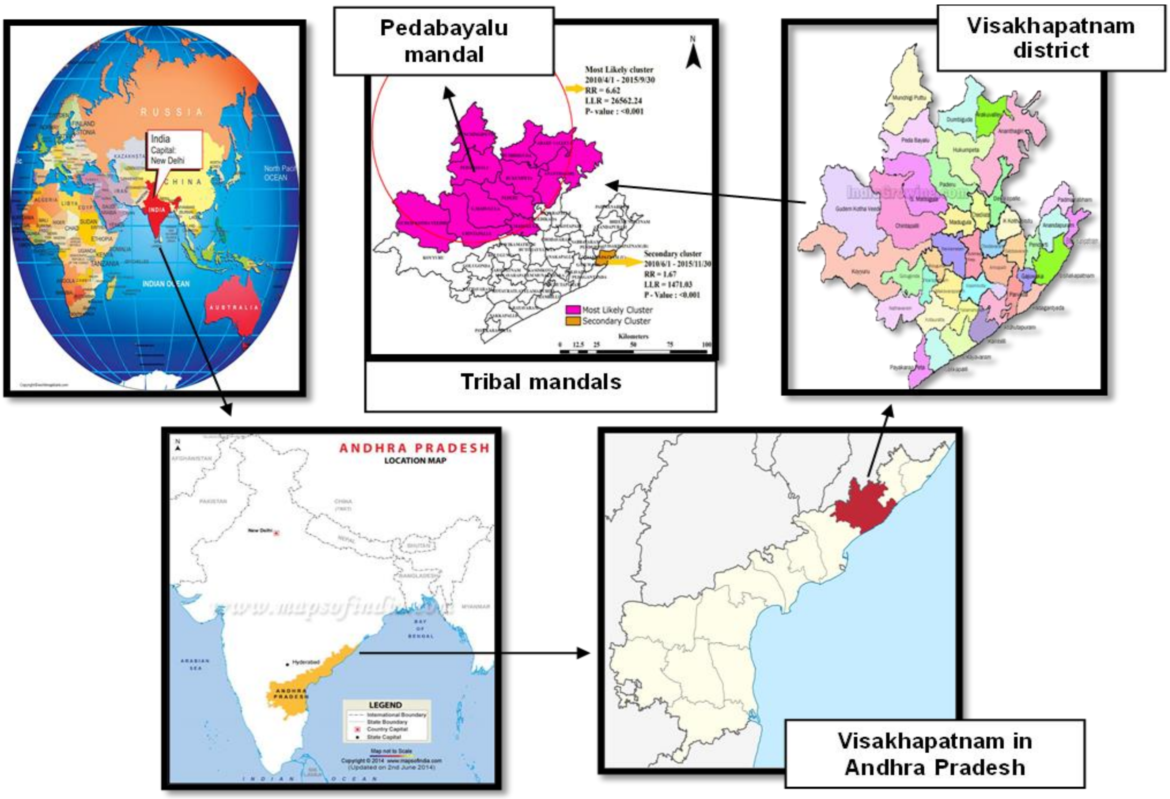

Fig. 1. Location map of selected study area

farming. Through, a comprehensive examination of cost structures, yield levels, and input-output dynamics, this study sheds light on the financial implications of ZBNF adoption in *rabi* rice cultivation. Furthermore, by comparing pre-ZBNF and post-ZBNF scenarios, it identifies key drivers of cost reduction and productivity enhancement associated with ZBNF practices. Such insights are instrumental in guiding policy formulation, extension services, and farmers training programs aimed at promoting sustainable agricultural practices like ZBNF.

2. METHODOLOGY

2.1 Data Collection

The research work was conducted in tribal area of Visakhapatnam district of Andhra Pradesh, India. From eleven tribal mandal's of the district one mandal with maximum ZBNF tribal farmers was purposively selected for the study. From selected mandal one cluster was randomly selected and from this cluster two ZBNF villages were selected randomly. A list of all the benefited tribal farmers in selected ZBNF villages was prepared and classified in two strata i.e. marginal farmers (<1 ha), small farmers (1-2 ha). And 50 per cent of tribal farmers were selected in each stratum by using proportional random sampling technique. Through, pretested interview schedule, primary data were collected for the agricultural year 2014-15 (before ZBNF) and 2018-19 (after ZBNF) for the study.

2.2 Analytical Procedures

Following analytical tools were used for the study-

A. Percentage change =(change in value after ZBNF -value before ZBNF)/(value before ZBNF) x 100%
B. Additional cost (₹): Total variable cost after ZBNF -Total variable cost before ZBNF
- Cost that does not exist at current time but will be incurred if the change is made.

C. Additional returns (₹): Gross returns after ZBNF- Gross returns before ZBNF
- Revenue to be received only if the alternative/change is adopted.

D. Additional net return (₹): The difference between additional returns and additional cost
E. Cost concepts

- Cost of production (₹/quintal) = (Total cost(₹/ha) -value of by product(₹/ha))/(yield quintal per hectare)

F. Profitability Concepts:

- Gross income = value of main product + value of by-product
- Benefit cost ratio = $\frac{Gross\ income}{Total\ cost}$

3. RESULTS AND DISCUSSION

3.1 Different ZBNF farm interventions adopted in *rabi* rice

The Table 1 reveals high level of adoption of various Zero Budget Natural Farming (ZBNF) farm interventions among respondents. Notably, all surveyed farmers reported adopting Farmyard Manure (FYM), Beejamrutham, Achhadana/Mulching, and Waaphasa/Moisture, indicating widespread acceptance of these fundamental ZBNF techniques. Furthermore, a significant majority, comprising 87.50 per cent of respondents, embraced the use of Dravajeevamrutham, Neemastram, and Brahmastram, underscoring the popularity of these bio-inputs among ZBNF practitioners. These bio-inputs are known for their role in enhancing soil fertility and promoting plant health, aligning with the principles of ZBNF. Additionally, three-fourths of ZBNF farmers (75.00 per cent) applied Ganajeevamrutham during main field preparation to supplement nutritional resources, reflecting a strong inclination towards maximizing soil nutrition through organic means. However, the adoption of trap cropping, aimed at reducing pest attacks, was notably low, with only 12.50 per cent of ZBNF farmers employing this technique. This finding suggests a potential area for improvement and education among ZBNF practitioners regarding integrated pest management strategies. These findings are consistent with those reported by Monikha and Jansirani (2019), affirming the widespread adoption of key ZBNF interventions among farmers. The high adoption rates underscore the effectiveness and acceptance of ZBNF techniques in promoting sustainable agriculture and mitigating reliance on external inputs.

3.2 Economic viability of different ZBNF farm intervention in *rabi* rice

The implementation of Zero Budget Natural Farming (ZBNF) in rabi rice cultivation resulted in significant changes in additional costs, returns, net returns, and cost-benefit ratios, as depicted in Table 2.

3.2.1 Variable cost after adopting different ZBNF farm interventions

It is evident from Table 2 that the total variable cost after implementing ZBNF (₹32704.82/ha) was lower than before ZBNF (₹36415.52/ha), indicating a reduction of 10.20 per cent in total variable costs following ZBNF implementation. The notable infinite increase in the cost of seed treatment after ZBNF (₹46.31/ha) occurred due to the absence of seed treatment practices before ZBNF. Weeding cost, after ZBNF (₹ 4705.35/ha) was 2.39 per cent lower than before ZBNF (₹ 4820.62/ha). This reduction in weeding cost may be due to application of acchadana intervention after adopting ZBNF. Furthermore, the cost of plant protection interventions application increased by 114.29 per cent after ZBNF. The cost of winnowing, bagging, transportation, and other related expenses after ZBNF (₹2350.21/ha) was 2.52 per cent higher than before ZBNF (₹2292.47/ha), attributed to the increased yield of *rabi* rice after ZBNF.

Table 1. Different ZBNF farm interventions adopted/identified in *rabi* rice

S. No	Particulars	Percentage farmers adopted
1	**Nutrients supply**	
	a) FYM	100.00
	b) Ganajeevamrutham	75.00
	c) Dravajeevamrutham	87.50
2	**Plant protection**	
	a) Beejamrutham	100.00
	b) Neemastram	87.50
	c) Brahmastram	87.50
	d) Trap cropping	12.50
3	Achhadana/ Mulching	100.00
4	Waaphasa/ Moisture	100.00

Source: Survey data

Table 2. Cost of production of Rice in *Rabi* (₹/q)

S. No	Particulars	Before ZBNF	After ZBNF	% Change
A.	**Operational cost**			
1	Nursery preparation and removing seedling	2432.95	2432.95	0.00
2	Land preparation and bunds formation	8793.20	8793.20	0.00
3	Seed treatment application			
	a. Seed treatment	--	--	0.00
	b. Beejamrutham application	--	46.31	Infinite
4	Transplantation	4886.49	4886.49	0.00
5	Irrigation	185.25	185.25	
6	Weeding	4820.62	4705.35	-2.39
7	Nutrients supply interventions application			
	a. Fertilizer application	185.25	--	
	b. Dravajeevamrutham application	--	185.25	0.00
8	Plant protection interventions application			
	a. Pesticide application	86.45	--	
	b. Asthras application	--	185.25	114.29
9	Harvesting	2865.20	2865.20	0.00
10	Threshing	2470.00	2470.00	0.00
11	Winnowing, bagging, transportation, & others	2292.47	2350.21	2.52
	Total operational cost	29017.87	29105.45	0.30
B.	**Inputs cost**			
1	Seed	1111.50	1111.50	
2	Nutrients supply interventions			
	a. FYM	1078.57	489.89	
	b. Chemical fertilizers	4832.97	--	
	c. Ganajeevamrutham (222.30 kg)	--	629.11	
	d. Dravajeevamrutham (494 l)	--	726.18	
	Sub total	5911.53	1845.18	-68.79
3	Plant protection interventions			
	a. Plant protection chemicals	374.62	--	
	b. Beejamrutham (49.4 l)	--	188.21	
	c. Neemastram (247 l)	--	177.84	
	d. Brahmastram (24.7 l)	--	165.49	
	Sub total	374.62	531.54	41.90
4	Acchadana interventions (Azolla (1.16 kg))	--	111.15	infinite
	Total input cost	7397.65	3599.37	-51.30
C.	Total variable cost	36415.52	32704.82	-10.20
D.	**Returns**			
1	Yield(q/ha)	28.17	31.06	10.25
2	Rate (₹/q)	1500.00	1500.00	
3	Value of main product	42260.16	46590.38	10.25
4	Value of by- product	3705.00	3705.00	
5	Gross returns	45965.16	50295.38	9.42
E.	Additional cost		-3710.71	
F.	Additional return		4330.22	
G.	Additional net return		8040.92	
H.	Additional Cost/Additional Benefit ratio		-1.17	
I.	Cost of production (₹/q)	1161.23	934.34	-19.54

Source: Survey data

Regarding operational costs, the total operational cost after ZBNF (₹29105.45/ha) was marginally higher (0.30 per cent) than before ZBNF (₹29017.87/ha).

The cost of nutrients supply interventions after ZBNF (₹1845.18/ha) was comparatively lower than before ZBNF (₹5911.53/ha), showing a decrease of 68.79 per cent post-ZBNF. This decrease was due to the utilization of low-cost, locally available raw materials for preparing nutrient supply interventions. Conversely, the cost of plant protection interventions after ZBNF (₹531.54/ha) increased by 41.90 per cent compared to before ZBNF (₹374.62/ha), as there was no recommended practice of using chemical pesticides before ZBNF. The cost of acchadana interventions saw an infinite percentage increase after ZBNF, as there was no mulching practice before ZBNF. However, the total input cost after ZBNF (₹3599.37/ha) was significantly lower by 51.30 per cent than before ZBNF (₹7397.65/ha).

3.2.2 Additional cost and returns after adopting different ZBNF farm interventions

Following the adoption of various ZBNF farm interventions in *rabi* rice cultivation, there was a noticeable reduction in additional costs by ₹3710.71 per hectare. This reduction primarily stemmed from decreases in weeding costs by 2.39 per cent and costs associated with nutrient supply interventions (such as FYM, Ganajeevamrutham, Dravajeevamrutham) by 68.80 per cent. Conversely, the adoption of ZBNF interventions led to an increase in additional returns by ₹ 4330.22 per hectare. This increase was driven by a 10.25 per cent rise in the value of the main product post-ZBNF adoption. The resulting additional net returns amounted to ₹8040.92 per hectare. This increase was attributed to both the 10.25 per cent increase in the value of the main product and the reduction in additional costs by ₹ 3710.71 per hectare following the adoption of various ZBNF interventions in rice cultivation. The calculated additional cost-to-additional benefit ratio stood at -1:1.17, indicating a positive economic outcome. This suggests that after adopting different ZBNF interventions in rabi rice cultivation, cultivators earned an additional profit of ₹ 1.77 for every ₹ 1.00 saved, showcasing the economic viability of utilizing ZBNF farm interventions.

Key interventions, including nutrient supply interventions, plant protection interventions, and acchadana/mulching intervention, played significant roles in these changes. Notably, the most significant reduction in cost after ZBNF was observed in nutrient supply interventions (FYM, Ganajeevamrutham, Dravajeevamrutham) by 68.80 per cent. Conversely, there was a 41.90 per cent increase in cost after ZBNF in plant protection interventions. Additionally, the adoption of acchadana/mulching intervention (Azolla) after ZBNF showed an infinite percentage change in cost, reflecting its absence before ZBNF implementation.

3.3 Cost of Production of *rabi* Rice After Implementation of ZBNF

3.3.1 Cost After Adopting ZBNF

A careful examination of Table 2 reveals that after adopting Zero Budget Natural Farming (ZBNF), the cost of production decreased from ₹1161.23 per quintal to ₹934.34 per quintal, marking a reduction of 19.54 per cent. This reduction was attributed to a decrease in variable costs by 10.20 per cent and an increase in yield by 10.25 per cent. This trend aligns with the findings of Mehmood et al*.* (2011), Uma Amareswari and Sujathamma [21], and Devi et al. (2017). However, despite the decrease in production costs, the operational cost after ZBNF was slightly higher at ₹29105.45 per hectare compared to ₹29017.87 per hectare before ZBNF, showing a marginal increase of 0.30 per cent. This increase was primarily due to a significant rise in the cost of asthras application by 114.29 per cent and a moderate increase of 2.52 per cent in other operational expenses such as winnowing, bagging, transportation, etc. Moreover, ZBNF led to a substantial reduction in input costs, dropping from ₹7383.46 per hectare before ZBNF to ₹3599.37 per hectare after ZBNF, representing a reduction of 51.30 per cent. This decrease was mainly attributed to a significant reduction in the cost of nutrient supply interventions by 68.79 per cent.

3.3.2 Yield after adopting ZBNF

In terms of yield, ZBNF resulted in a notable increase from 28.17 quintals per hectare before ZBNF to 31.06 quintals per hectare after ZBNF, indicating a rise of 10.25 per cent. This increase in yield was attributed to the use of beejamrutham for seed treatment, azolla and jeevamrutham (ganajeevamrutham and dravajeevamrutham) as nutrient supply interventions, which is consistent with the findings of Pabby, Prasanna and Sing [22], Ninan et al. [23], Shubha et al. [24], Kasbe et al. [25], Sornalatha et al*.* [26], Devakumar et al. [27], Razavipour et al. [28], Fazeel et al. [29], Naveen et al. [30], Galab et al. [31], Oyange et al. [32], Saxena & Kumar [33] and Charapale et al. [34]

4. CONCLUSION

The study underscores the tangible benefits of Zero Budget Natural Farming (ZBNF) interventions for tribal farmers engaged in rabi rice cultivation. By implementing practices such as FYM, ganajeevamrutham, and dravajeevamrutham for nutrient enhancement, along with beejamrutham, neemastram, and brahmastram for plant protection, farmers have experienced notable improvements in both cost savings and yield enhancement. The transition to ZBNF has resulted in a notable reduction in additional expenses, particularly in nutrient supply and weeding costs, while simultaneously increasing the yield of the main product. This dual effect has significantly improved the economic viability of rabi rice cultivation in the study area. Furthermore, the calculated additional cost-to-benefit ratio of -1:1.17 reaffirms the favourable economic prospects associated with ZBNF adoption. These findings not only underscore the financial advantages of ZBNF practices but also highlight their potential to foster sustainable agricultural practices within the community. In conclusion, the study provides compelling evidence that the adoption of ZBNF interventions represents a promising pathway towards achieving both economic prosperity and environmental sustainability in agricultural systems, particularly in rabi rice cultivation among tribal farmers.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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