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YIELD GAP ANALYSIS OF PADDY IN TELANGANA STATE INDIA

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ABSTRACT

Paddy cultivation plays a vital role in India's agricultural sector, with Telangana being a significant contributor. The present study aims to quantify the gap between normal (non-progressive), progressive farmers and research station yields of paddy crops in Telangana state, and the constraints faced by the farmers in the cultivation of paddy. The purposive sampling method was used to collect the production data from progressive farmers and research stations comprising a total of 90 non-progressive or normal farmers, 15 progressive farmers and 3 research stations across the northern, central and southern agro-climatic zones of Telangana. Cost concepts and yield gap analytical tools were used in analyzing the data. The results revealed that progressive farmers incur higher production costs across all cost components compared to average farmers, with amounting to Rs. 57,320.59 per acre for progressive farmers and Rs. 54,086.23 per acre for average farmers. Yield Gap-I (progressive vs. average farmers) and Yield Gap-II (research station vs. average farmers) highlight substantial differences, with state-level gaps of 504 kg per acre and 195 kg per acre, respectively. Progressive farmers achieved higher yields (31.09 quintals per acre) than average farms (26.05 quintals per acre), emphasizing the potential for improved agricultural productivity. The study emphasizes the need for targeted interventions to reduce yield gaps through enhanced extension services, cost-effective inputs, and improved infrastructure. Strengthening the linkages among farmers, extension agents, and researchers is crucial to bridging resource and knowledge gaps, thereby boosting productivity and profitability in paddy cultivation across Telangana.

Key words: Cost and returns, Inputs, Potential yield, Production and marketing constraints, Yield gap.

Introduction

Paddy is one of the most consumed cereals and a staple food of South Asian countries. These countries collectively produce 90% of the global paddy, with India contributing 10%. Rice and rice-based foods account for 31.5% of India's calorific intake (FAO, 2016).

Rice is the most important food crop for more than two-thirds of the Indian population. India has the largest area under rice cultivation, as it is one of the country's principal food crops.

Rice is the dominant crop in India, making it one of the leading producers in the world. As a tropical plant, rice flourishes in a hot and humid climate. It is primarily grown in rain-fed areas that receive heavy annual rainfall, which is why it is fundamentally a *Kharif* crop in India. However, in regions with comparatively less rainfall, rice is also cultivated through irrigation. It serves as the staple food in the eastern and southern parts of India. Paddy is the major cultivated crop in the state of Telangana with around 64.54 lakh acres during the *Vaanakalam* (*kharif*) season of 2022-23 and 35.84 lakh acres during the *Yasangi (rabi)* season of 2021-22. Telangana is a major rice-producing state with a productivity of 3327 kg/ha. Telangana is the 11th largest Indian state with a geographical area of 11.2 million hectares (Mha). Rice accounted for 50.3% (4.12 Mha) of the total gross cropped area in Telangana during 2020. Paddy is extensively grown across Telangana and is used for both human consumption and animal feed.

Rice can be cultivated using different methods depending on the region, but traditional farming techniques are still widely used for harvesting in India. In this context, the yield gap in the rice *i.e.* the difference between potential yield (yield claimed by the research station) and the actual yield (yield obtained by the farmer in his field) stands as a valuable performance indicator for the rice production in the country.

The yield gap analysis is a potent research technique introduced during the 1970s. Developed by the International Rice Research Institute (IRRI), it is extensively used to measure and analyze determinants of yield gaps. The concept of yield gap provides the information base in this regard. The findings of such research have many implications for policy formulation, aimed at alleviating the constraints causing the yield gaps (Gavali *et al.*, 2011; Kalamkar, 2004; Nagaraj, 2002 and Rajagopalan, 1986).

To meet the increased demand for rice juxtaposed with increased population growth, the adoption of improved crop production technologies in the farmer's field emerges as the most important solution, which in turn serves to bridge this yield gap. Against the backdrop of this situation, it was designed to conduct the following study with the objectives as detailed below

To estimate the yield gap in paddy production across the three zones of Telangana *viz.*, Northern Telangana Zone (NTZ), Central Telangana Zone (CTZ) and Southern Telangana Zone (STZ) and to study the constraints the rice growers face in paddy cultivation.

Materials and Methods

This study is based on primary data collected through well-structured schedules. The purposive sampling method was used to include 30 normal (non-progressive) farmers and 5 progressive farmers from each zone comprising a total of 90 farmers and 15 progressive farmers across the north, central, and southern regions of the Telangana state. Additionally, data was gathered from 3 research stations, one from each region.

Cost concepts

The cost concepts approach to farm costing is widely used in India (Raju and Rao, 1990). These cost concepts include Cost A1, Cost A2, Cost B1, Cost B2, Cost C1, Cost C2 and Cost C3. In the study Cost A1, Cost A2, Cost B, Cost C, fixed and variable costs were estimated for progressive and non-progressive farmers. Besides these, gross return, net return, and benefit-to-cost ratio were estimated. Cost A1 = All actual expenses in cash and kind incurred in production by the producers. The items included in cost A1 are costs of hired human labour, hired bullock labour, owned bullock labour, seeds, plant protection chemicals, manures (owned & purchased), fertilizers, insecticides and pesticides, irrigation, depreciation on farm machinery, equipment, farm building and farm implements, Land revenue, cesses and other taxes, Interest on working capital and Miscellaneous expenses. Cost A2 = Cost A1 + Rent paid for leased-in land, Cost B = Cost A2 + Interest on value of owned capital assets (excluding land) + Rental value of owned land, Cost C = Cost B + Imputed value of family labour.

Yield Gap Analysis

- **Potential yield (Y_p):** Potential yield refers to that which is obtained in the experiment station. The yield is considered to be the absolute maximum production of the crop possible in the given environment, which is attained by the best available methods and with the maximum inputs in trials on the experiment station in a given season.
- **Potential farm yield (Y_d):** Potential farm yield is the yield obtained on the demonstration plots on the farmers' fields in the study area. The conditions on demonstration plots closely approximate the conditions on the cultivators' fields with respect to infrastructural facilities and environmental conditions.
- **Progressive farmers yield (Y_{pf}):** The yield obtained by the progressive farmers in the natural environmental conditions was considered as progressive farmers yield and this yield was closely related to actual farmers yield in the study area.
- **Actual yield (Y_a):** Actual yield refers to the yield realized by the farmers on their farms under their management practices.

Yield gap-I (YG-I)

It is the difference between potential yield (Y_p) the yield achieved by progressive farmers (Y_{pf}). Yield gap-I (Manivasagam *et al.*, 2024) is hypothesized to be caused by either the environmental differences between experiment station and farmers' fields or by non-transferable technology

$$YG\text{-}I = Y_p - Y_{pf}$$

Table 1: Cost and Return Analysis of Paddy.

Cost components	NTZ		STZ		CTZ		Overall sample	
	Rs. / acre (Farmer)	Rs. /acre (Progressive Farmer)	Rs. / acre (Farmer)	Rs. /acre (Progressive Farmer)	Rs. / acre (Farmer)	Rs. /acre (Progressive Farmer)	Rs. / acre (Farmer)	Rs. /acre (Progressive Farmer)
Total human labour	12000.00	12100.00	13640.00	14400.00	12900.00	8815.00	12846.67	11771.67
Total bullock labour	0.00	0.00	1250.00	0.00	0.00	0.00	416.67.00	0.00
Total machinery labour	8200.00	9600.00	9800.00	10800.00	9100.00	12400.00	9033.33	10933.33
Seeds	800.00	800.00	1221.00	1360.00	2126.00	2450.00	1382.33	1536.67
Fertilizers	4145.00	4800.00	5924.00	5200.00	4701.00	4523.00	4923.33	4841.00
Plant protection chemicals	2210.00	3215.00	3420.00	4200.00	3017.00	2370.00	2882.33	3261.67
Interest on working capital @ 12.5% (WC*0.125*0.25)	854.84	953.59	1101.72	1123.75	995.13	954.94	983.90	1010.76
Total variable costs	28209.84	31468.59	36356.72	37083.75	32839.13	31512.94	32468.56	33355.09
Depreciation	500.00	650.00	770.00	850.00	780.00	820.00	683.33	773.33
Rental value of owned land	9400.00	9800.00	9024.00	9250.00	8400.00	11400.00	8941.33	10150.00
Interest on fixed capital @ 10%	495.00	522.50	493.00	480.00	459.00	611.00	482.33	537.83
Total fixed costs (TFC)	10395.00	10972.50	10287.00	10580.00	9639.00	12831.00	10107.00	11461.17
Total cost (TVC+TFC)	38604.84	42441.09	46643.72	47663.75	42478.13	44343.94	42575.56	44816.26
Main Product (quintals)	25.50	29.72	26.54	31.55	26.11	32.00	26.05	31.09
By product	2400.00	3000.00	2450.00	2550.00	2300.00	2550.00	2383.33	2700.00
Price (Rs. /quintal)	2060.00	2060.00	2084.00	2096.00	2050.00	2050.00	2064.67	2068.67
Gross return	54930.00	64227.32	57759.36	68678.80	55825.50	68150.00	56171.62	67018.71
Net return	16325.16	21786.23	11115.64	21015.05	13347.38	23806.06	13596.06	22202.45
B:C ratio	1.42	1.51	1.24	1.44	1.31	1.54	1.33	1.5

Yield gap-II (YG-II)

It is the difference between the potential farm yield (Y_d) and the actual farm yield (Y_a) (Manivasagam *et al.*, 2024).

$$YG\text{-}II = Y_d - Y_a$$

It is hypothesized to be caused by biological and socio-economic constraints; biological constraints stem from the non-application of essential production inputs and the socio-economic constraints from the social or economic conditions that prevent farmers from using the recommended technology (Pushpa and Srivastava, 2014).

$$\text{Average yield gap} = \frac{\text{Potential yield - Actual yield}}{\text{Potential yield}} \times 100$$

Results and Discussion

The cost and return analysis of paddy cultivation across different agro-climatic zones in Telangana *viz.*, Northern Telangana Zone (NTZ), Southern Telangana Zone (STZ), and Central Telangana Zone (CTZ) revealed notable variations between farmers and progressive farmers (Table 1).

A perusal of Table 1 showed that at the zonal level, the total cost of cultivation in average farms was highest in STZ (Rs. 46,643 per acre), followed by NTZ (Rs. 42,575 per acre) and CTZ (Rs. 42,478 per acre). At the

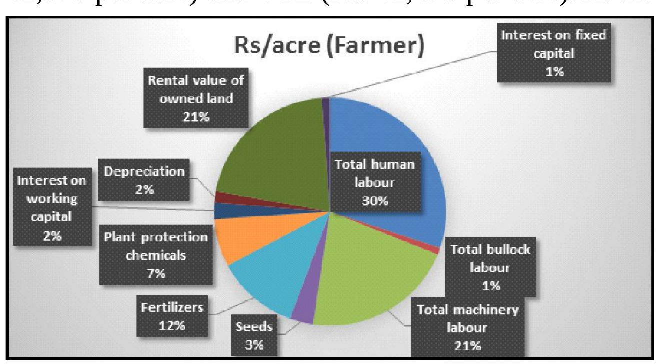

Fig. 1: Average farmers cost of cultivation.

state level (overall sample), the total cost of cultivation for progressive farms was Rs. 44,816 per acre, while for average farms, it stood at Rs. 42,575 per acre. More expenditure was incurred towards human labour component in the case of normal farmers while more expenditure was incurred in machine labour and plant protection chemicals for Progressive farmers (Fig. 1 and 2). The data indicated that both human labor and machinery labor are crucial components of paddy cultivation. Progressive farmers spend less on human labor compared to regular farmers, which might indicate their preference for using more machinery and adopting modern agricultural practices to increase efficiency and reduce labor costs. Both regular and progressive farmers seem to invest similar amounts in seeds and fertilizers. Progressive farmers spend more on plant protection chemicals, which indicates their proactive approach in managing pests and diseases. This could lead to healthier crops and increased yields, contributing to higher returns.

Progressive farms achieved higher productivity, yielding an average of 31.09 quintals per acre compared to 26.05 quintals on average farms. Despite the similarity in price per quintal (Rs. 2,064.67 for average farms and Rs. 2,068.67 for progressive farms), progressive farms achieve greater gross returns (Rs. 67,018.71 per acre) compared to Rs. 56,171.62 per acre for average farms. This higher return translates into significantly greater net returns for progressive farms (Rs. 22,202.45 per acre) relative to Rs. 13,596.06 per acre for average farms. The benefit-cost (B:C) ratio further supports this trend, with progressive farms exhibiting a ratio of 1.50, surpassing the 1.33 recorded for average farms, indicating superior efficiency and profitability.

Among average farms, STZ recorded the highest gross returns (Rs. 57,759 per acre), followed by CTZ (Rs. 55,825 per acre) and NTZ (Rs. 54,930 per acre). The B:C ratio for average farms was highest in NTZ

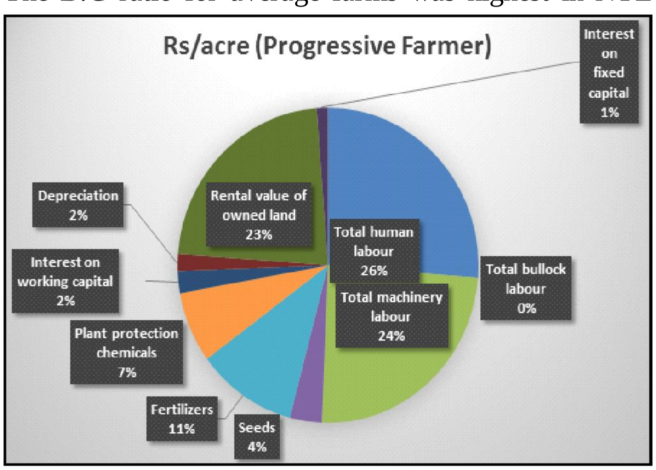

Fig. 2: Progressive farmers cost of cultivation.

Table 2: Cost of cultivation according to cost concepts (Rs. /acre).

Cost components	Average farmer	Progressive farmer
Cost A1	33,151.90	34,128.43
Cost A2	42,093.23	44,278.43
Cost B 1	33,634.23	34,666.26
Cost B2	51,516.90	54,966.26
Cost C1	36,203.56	37,020.59
Cost C2	54,086.23	57,320.59
Cost C3= Cost C2 + 10% of Managerial cost of C2	58,343.79	61,802.22

(1.42), followed by CTZ (1.31) and STZ (1.24), reflecting regional variations in cost-effectiveness. The overall financial viability of paddy cultivation is evident, as indicated by B:C ratios exceeding 1. However, progressive farmers achieve substantially greater profitability due to their higher productivity and optimized cost structures, reinforcing the economic advantage of improved farming practices. The results were in line with the study of Chaithanya and Maurya (2020) and Pathak *et al.*, (2021) that the benefit-cost ratio for paddy cultivation for overall farmers is 1.67 and the study by Namrata *et al.*, (2020) showed that paddy cultivation in Telangana has B:C ratio more than one.

Table 2. shows that regarding cost components at the state level, the values for Cost A1, Cost A2, Cost B1, Cost B2, Cost C1, Cost C2, and Cost C3 in progressive farms were Rs. 34,128, Rs. 44,278, Rs. 34,666, Rs. 54,966, Rs. 37,020, Rs. 57,320, and Rs. 61,802 per acre, respectively. In comparison, for average farms, the corresponding costs were Rs. 33,151, Rs. 42,093, Rs. 33,634, Rs. 51,516, Rs. 36,203, Rs. 54,086, and Rs. 58,343 per acre, respectively (Fig 3.). A similar expenditure on paddy cost of cultivation was observed in the study by Ramyasri *et al.*, (2022).

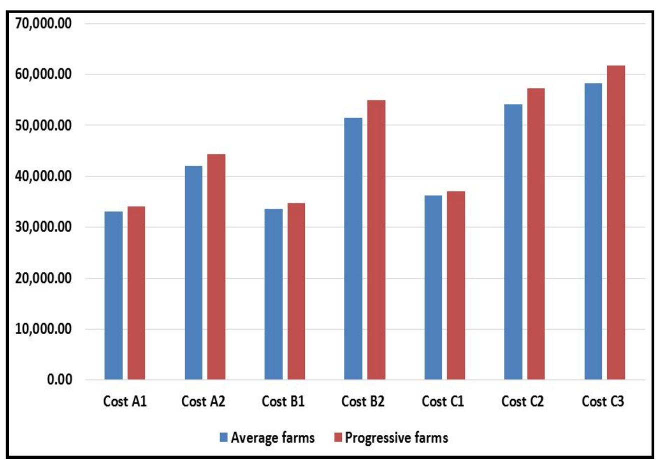

Fig. 3: Cost of cultivation according to cost concepts Rs./ acre.

Table 3: Yield gap analysis of Telangana.

Yield Gap	YG-I (kg per acre)	YG-II (kg per acre)	YG-I (Rs. per acre)	YG-II (Rs. per acre)
Southern Telangana Zone	501	146	10,440	3,042
Central Telangana Zone	589	189	12,074	3,874
Northern Telangana Zone	422	250	8,697	5,150
Telangana	504	195	10,407	4,026

Yield gap analysis

The yield gap was defined in two types namely Yield Gap – I, the difference in yield between progressive farmers and normal farmers and Yield Gap – II, the difference in yield between research station results and normal farmers.

A perusal of Table 3 showed that the Yield Gap-I, which represents the difference between progressive and average farmers, was highest in CTZ (589 kg per acre, Rs. 12,074 per acre), followed by STZ (501 kg per acre, Rs. 10,440 per acre) and NTZ (422 kg per acre, Rs. 8,697 per acre). At the state level, Yield Gap-I was recorded at 504 kg per acre, translating to a monetary loss of Rs. 10,407 per acre. Similarly, Yield Gap-II, which indicates the difference between research station yields and average farmers, was highest in NTZ (250 kg per acre, Rs. 5,150 per acre), followed by CTZ (189 kg per acre, Rs. 3,874 per acre) and STZ (146 kg per acre, Rs. 3,042 per acre). The state-level Yield Gap-I stood at 195 kg per acre, amounting to Rs. 4,026 per acre. Addressing just 10% of Yield Gap-I across Telangana's 10 lakh acres of paddy land could contribute an additional Rs. 1,040.72 crore to the state's GSDP, while bridging 10% of Yield Gap-II could add Rs. 402.61 crore. In terms of yield, average sample farms in STZ recorded the highest yield (26.54 quintals per acre), followed by CTZ (26.11 quintals per acre) and NTZ (25.50 quintals per acre). At the state level, progressive farms achieved an average yield of 31.09 quintals per acre, whereas average sample farms yielded 26.05 quintals per acre. Similar results were found in the study by Balasubmmeni *et al.*, (2005) and (Shekhar and Roy, 2020) that the estimates of yield gap analysis proved the existence of a yield gap ranged from 41 per cent (low adopter) to 23 per cent (high adopter) of recommended practices in paddy cultivation.

Constraints in Paddy Cultivation

The study identified and ranked key constraints affecting paddy cultivation based on farmers' perceptions and presented in Table 4. The high cost of fertilizers emerged as the most significant constraint, followed by the high cost of plant protection chemicals and high labor costs, which placed second and third, respectively. The unavailability of machinery and equipment ranked fourth, highlighting the challenges in mechanization. Labor shortages were another notable issue, ranking fifth.

Table 4: Constraints faced by Paddy farmers.

S. No	Constraints	Rank
1.	High cost of fertilizers	1
2.	High cost of plant protection chemicals	2
3.	High labour cost	3
4.	Unavailability of machinery and equipment	4
5.	Labour unavailability	5
6.	Occurrence of pest and diseases	6
7.	Lack of technical knowledge	7
8.	High cost of seed	8
9.	Unavailability of credit	9
10.	Unavailability of seed	10

Other constraints included the occurrence of pests and diseases (6^{th} rank), lack of technical knowledge (7^{th} rank), and high cost of seeds (8^{th} rank), all of which impact productivity and profitability. Additionally, the unavailability of credit (9^{th} rank) and seed shortages (10^{th} rank) were identified as significant barriers to effective crop management. Addressing these constraints through policy interventions and support mechanisms could enhance paddy production efficiency and farmer profitability. Similar findings were presented in the study Nirmala and Muthuraman (2009), that pests and disease incidence, lack of remunerative price, and labour shortage were the major constraints in rice production. High cost of agriculture inputs positively related with the yield gap (Blasubramani *et al.*, 2005).

Conclusion

Rice occupies a pivotal place in India's food security and livelihood system. The study highlighted significant yield gaps in paddy cultivation across Telangana, with Yield Gap-I (504 kg per acre) and II (195 kg per acre) indicating potential economic gains if addressed. Progressive farms outperform average farms in yield, cost-efficiency, and net returns, demonstrating higher profitability. Key constraints faced by paddy farmers include high input costs, labor issues, and limited access to machinery, credit, and technical knowledge, underscoring critical challenges in enhancing productivity and profitability.

Reducing the yield gap in paddy production is essential for improving farmers' livelihoods and ensuring food security. While progressive farmers have demonstrated the potential for better yields through improved management practices, non-progressive farmers need targeted support to bridge the resource and knowledge gaps. With coordinated efforts and focused interventions, the productivity and profitability of paddy cultivation in Telangana can be significantly enhanced.

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