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Yield Gap and Impact Analysis of Rice Variety CAU R-1 in Different Location of Leparada District of Arunachal Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. Author RN collected and analyzed the samples. Authors RN and KLC conceptualized the study and prepared original draft. Authors KLC and MK edited the manuscript. Authors WL, MC and LT reviewed and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Front Line Demonstration on rice variety CAU R-1 was conducted in the Leparada District of Arunachal Pradesh in the year of 2019 to 2022 by Krishi Vigyan Kendra, West Siang during the Kharif season. The demonstration was conducted in 40 farmers' field covering 18 hectares of area. The study was conducted for Grain yield, Yield gap, Technological gap, Extension gap, Economic gains and Technology Index. The demonstration showed that the average grain yield was lowest in 2019 (43.00 q/ha) and highest in 2022 (46.50 q/ha). The average grain yield of farmers' practice was lowest with 30.00 q/ha in 2019 and highest in 2022 with 34.86 ql/ha. Percentage of increased yield of the demonstration over the farmers' practice ranges from 33.30% to 43.30%. In case of Technological gap/yield gap, extension gap and technological index the value decreased from 2019 to 2022 with the value of 27.00 to 23.50 (Technological gap/yield gap), 13.00 to 11.64 (extension gap) and 38.60% to 33.60 % (technological index). In term of economic study, the benefit cost ratio of the demonstration ranges from 1.72:1 (2019) to 1.76:1 (2022) whereas the farmers' practice benefit cost ratio ranges from 1.16:1 (2019) to 1.28:1 (2022). The yield potential of rice can be increased to a great extent by using high yielding varieties with improved technologies through front line demonstration. Accordingly, the production and the productivity of rice will be increased resulting in sustainable and profitable farming at the same time reducing the technology gaps.

Keywords: Extension gap; impact; rice; technology gap; technology index; yield gap.

1. INTRODUCTION

Worldwide rice (*Oryza sativa*) is the third major cereal grain crop and more than half of the world population consumes it as a staple food [1]. Due to rice's wide adaptability in various environments and lower cultivation risk, several farmers favored growing rice over other crops. Rice is the stable food of more than 60% of world's population. It is the stable food of Arunachal Pradesh. Rice is primarily a high energy food. The protein content of milled rice is usually 6-7%, the biological value of its protein is high. The fat content of rice is low (02.00 to 2.50%) and much of the fat is lost during milling. Rice contains a low % of calcium. There are several uses of rice milling byproducts such as cattle and poultry feed. The local people of Arunachal Pradesh used rice bran for preparing local brew. In poultry farming it is also used as litter. Arunachal Pradesh lies in Eastern Himalayan Region. The agriculture practices in the state can be broadly classified into two types: shifting cultivation (Jhum), which is practiced on hill slopes, and settled farming, which is practiced in plains, valleys, foothills, terraced slopes, etc. The production of rice as per Arunachal State record is 244.700 tons in 2020. Leparada District as an area of 982.67 sq km with a population of 20865 as per 2020 census at 578 metres MSL. Total gross cropped area of paddy in Leparada is 3532 hectares with a production of 8610 Quintals as per 2020-2021 census as reported in Statistical Abstract of Arunachal Pradesh. Directorate of Economics & Statistics Government of Arunachal Pradesh [2] and Agricultural Production: Rice: Arunachal Pradesh 1981 – 2020 [3]. which is very low and could not meet the increasing demand for ricewith the increase in population every year. Using of high yielding varieties is a much to meet ever increasing demand of rice.

2. MATERIALS AND METHODS

The present study was conducted in Basar Circle of Leparada District of Arunachal Pradesh by KVK West Siang in the year 2019 to 2022 during the *kharif* season and the details of climatic conditions of the villages under study is given in Table 1. The demonstration was conducted in 40 farmers' field covering 18 hectares of area. The recommended package of practices viz., seed treatment, nutrient management, and whole package of practices were used in the demonstrations. CAU R-1under study is taken for front line demonstration as shown in Table 2. Soil type of the demonstration areas was generally clay loam and the fertility ranges from low to medium. Transplanting was done when the seedlings were 27 days old with a spacing of 20 cm x 20 cm. Sowing was done during the second and third week of June. Data are recorded from yield and economics from both the demonstration (CAU R-1) and farmers practice (Mipun). Other data viz, technology gap, extension gap and the technology index were calculated with the techniques provided by Samui et al. [4] and Meena and Dudi, [5] as stated below:

Table 1. Climatic Attributes of Particular Locationsunder study

Sl. No.	Village	Latitude (N)	Longitude (E)	Altitude	Average Rainfall (annual)	Soil type
1	Chirni	27.9612	94.6614	708 m	124.28mm	Clay loam
2	Bam	28.0259	94.6698	957 m	124.28mm	Clay loam
4	Nyigam	27.9279	94.6932	987 m	124.28mm	Clay loam

Table 2. Details of recommended practice and farmer's practice

Particulars	Recommended practice	Farmer's practice
Variety	CAU R-1	Mipun
Seedling age	27 days	31 days
Spacing	20cm x 20cm	No specific spacing maintained
Irrigation	Rainfed	Rainfed
Fertilizer dose	60:40:40 (N:P:K kg/ha)	No balance application
Plant protection measures	Need based	No balance application

Technology gap = Potential yield – Demonstration Plot yield

Extension gap = Demonstration Plot yield – Farmer's plot yield

$$Technology\ index\ = \frac{Pi\ -\ Di\ \times 100}{Pi}$$

Where, Pi= Potential yield; Di= Demonstration yield

Yield gap analysis: The Yield gap has been computed using basic statistical procedures based on the actual and potential farm yields per hectare. Singh and Feroze [6].

3. RESULTS AND DISCUSSION

3.1 Grain Yield

The performance of Rice var. CAU R-1 during the front-line demonstration years showed that the mean grain yield of 44.93 q/ha was recorded in all the years under demonstrated plots, which was higher than the local check of 32.62 q/ha. The maximum grain yield of 46.50 q/ha was recorded during 2022 and the minimum grain yield of 43.00 q/ha during 2019. The yield increased by 37.93% on an average over the local check (Table 3). This demonstrates quite clearly the benefits of using better technology for front-line demonstration. The results closely align with the conclusions of Chongloi et al. [7] and Ahmed et al. [8].

3.2 Yield Gaps

To estimate the production gap during the demonstration years (2019 to 2022), the yield of farmers' var. Mipun and rice variety CAU R-1 under demonstration were compared. Throughout the years of research, it has been noted that the yield gap/technology gap ranges from 23.50 to 27.00 q/ha. The technological gap was at its lowest in 2022 (23.50 q/ha) and at its peak in 2019 (27.00 q/ha). The viability of advanced technology in agricultural settings was demonstrated by the technology index. According to Singh et al. [9], the more feasible technology is, the lower its value on the technology index. The higher technological gap may be caused by inefficient rainfall distribution, variations in soil fertility, unfavorable weather patterns, and issues with crop management unique to a certain location. The findings are also similar to Singha et al. [10] and Nikulsinh [11].

3.3 Extension Gaps

We found that, there was largest extension gap of13.00 q/ha in 2019—followed by 12.50 q/ha in 2020 and 11.64 q/ha in 2022. This emphasized the need for farmers to receive education via a variety of channels in order to promote the adoption of improved agricultural production techniques and halt the existing trend of a sizable extension imbalance. This will thus reverse the concerning trend of the widening extension gap by utilizing the latest production methods and high-yielding cultivars. In due course, farmers will be forced to abandon outdated methods in favour of the more

Table 3. Productivity, technology gap, extension gap and technology index in rice var. CAU R-1 under FLD

Year	Area (ha)	No. of farmers	Grain yield (t/ha)			% increase over control	Tech gap/Yield gap (q/ha)	Ext. Gap (q/ha)	Tech. Index %
			P	D	FP				
2019	3.50	10	70	43.00	30.00	43.30	27.00	13.00	38.60
2020	3.50	10	70	44.50	32.00	39.10	25.50	12.50	36.40
2021	5.50	10	70	45.70	33.60	36.00	24.30	12.10	34.70
2022	5.50	10	70	46.50	34.86	33.30	23.50	11.64	33.60
Total	18.00	40							
Average		**70**	**44.93**	**32.62**	**37.93**	**25.08**	**12.31**	**35.83**	

P= Potential D= Demonstration FP= farmer's Practice

Table 4. Economics of Rice var. CAU R-1 under FLD and Farmer's practice var. Mipun

Year	Cost of cultivation (Rs/ha)		Gross Return (Rs/ha)		Net return (Rs/ha)		BC ratio	
	Demonstration	Farmer's practice	Demonstration	Farmer's practice	Demonstration	Farmer's practice	Demonstration	Farmer's practice
2019	50000	51500	86000	60000	36000	8500	1.72	1.17
2020	51500	52200	89000	64000	37500	11800	1.73	1.23
2021	52000	53100	91400	67200	39400	14100	1.76	1.27
2022	52800	54200	93000	69720	40200	15520	1.76	1.29
Average	51575	52750	89850	65230	38275	12480	1.74	1.24

advanced ones. Chongloi and Singh's findings from 2022 are consistent with this one.

3.4 Technology Index

The economic feasibility of modern technology in the hands of farmers was demonstrated by the technology index data (Table 3). When an innovation's technology index values are lowest, it is more viable. The technology index reached its maximum of 38.60% in 2019 and its lowest point of 33.60% in 2022. This suggests that there is a significant disconnect between the technology developed at research institutions and the technology applied by farmers. Higher technology index reflected the insufficient extension services for transfer of technology [12]. The results are in conformance with Girish et al. [13]. However, the district's farmers will gradually embrace the developed technology to speed up production and improve productivity in rice cultivation as a result of the deployment of HYVs, the demonstration of enhanced technology, and a vigorous awareness campaign [14].

3.5 Economic analysis

For the purpose of computing the economics, the commodity prices that were in effect during the demonstration study were used. When compared to farmers' practices, frontline demonstrations where recommended practices were followed showed higher profitability in terms of gross return (Rs. 89850/ha), net returns (Rs.38275/ha), and benefit:cost ratios (1.74:1). This was evident from the economic analysis of the data (Table 4) for rice during the study period. It was discovered that the benefit cost ratios under demonstration (1.74:1) exceeded the local check (1.24:1). This could be because farmers are using better technologies to produce bigger yields than they were using the local rice variety Mipun. Similar results have been reported by earlier by Patil et al. [15] and Sachan et al. [16].

4. CONCLUSION

Performance of the CAU R-1 rice variety under Front Line Demonstrations increased the yield growth and revenue but reduced the yield gap when suggested agronomic techniques are demonstrated. The years of demonstrations showed an average output increase of 37.93% over farmer methods. Based on the aforementioned results, it can be concluded that the district's rice productivity can be enhanced by integrating enhanced production technology with HYV rice seeds, which outperformed local checks and significantly lower the technology index. The efficiency and profitability of rice production could be increased by using improved variety seeds and scientific farming techniques. The demonstration's economic viability can be explained by the favorable benefit-cost ratio, which further encouraged the farmers to accept the intervention.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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