Yield gap analysis for Enhancement of Rice production and productivity under rain-fed condition of Chandel, Manipur, India

ABSTRACT

The study was conducted at Chandel district, Manipur state aiming to assess the impact of riceproduction under Frontline Demonstration (FLD) in terms of yield, yield gap/extension gap, technological gap and economic gains during kharif season from 2018 to 2022. The present Front LineDemonstrationon rice var. RC-Maniphou-13 was carried out by Krishi Vigyan Kendra, Chandel, ICAR-RC for NEH Region, Manipur Centre at 40 hectares in 92 farmers' field of different villages. The result indicated that average grain yield of rice in demonstration field ranged between 57.60 to 60.60 q/ha whereas in farmers' practices, it was 42.50 to 47.33 q/ha during demonstrated years. The percent increase in yield with Demonstration Practices over Farmers' Practices ranged between 28.04to 35.53. The yield gap/technological and extension gap were from 9.40 to 12.40 and 13.27 to 15.10 q/ha respectively. Similarly, technological index was decreased from 17.71 to 13.43 per cent during the study period. The benefit cost ratio was from 1.98 to 2.65 under demonstration, while it was from 1.09 to 1.91 under farmer practices. By conducting Front Line Demonstration on improved practices with HYV of proven technologies in farmers' field, yield potential of rice enhanced to a great extent which increased in production and productivity, also the income level of farmers has improved the livelihood of farming community in the region by reducing the technology gaps.

Key words: *Extension gap;* Rice;*Technology gap; Technology index; Yield gap;*

Introduction:

"Manipur has a total geographical area of 22,327 sq.km of which only about 231.19 sq.km lands is available for agriculture. From the total gross crop area 90% is under paddy cultivation" (Singha and Mishra, 2015). The 80% of the total population in Manipur are engaged in agriculture and allied sectors (Roy et al., 2018).When it comes to rice output among the North-eastern states of India, Manipur ranks as second. However, the production and productivity of the local cultivars including the improved rice crop could not meet the demand of the 30 lakhs population. The average productivity of rice in the valley districts is 3.1t/ha as against the 2.8t/ha of the country. However, the average production and productivity trend of rice for the last 10 years in Manipur signifies unsustainabilityand more varietal diversification can minimize the yield gap of rice production and productivity scenario in the state of Manipur(Motilal, et al., 2023). To feed the rapidly growing population, it is essential to increase the production of rice as it is the staple diet of the people of the state. Since the yield of high-yield variety (HYVs) is higher than that of traditional/local varieties, the government's upgraded technology and HYV program, since it is instrumental in helping the state become self-sufficient in the production of food grains. Agriculture technology is never completely accepted by the farmers, as such there always appears to be a gap between the recommended technology by the scientists and it’s modified form at the farmer’s level. Therefore, the main obstacle to the nation's efforts to increase agricultural productivity is the technology deficit. A need is to reduce the technological gap between the agricultural technology recommended by the scientists and its acceptance by the farmers on their field.

The difference between the farm level yield and the highest feasible yield is known as the yield gap. The yield of experimental or on-farm plots with no physical, biological, or financial constraints and with established management techniques at a specific period and in a specific ecosystem is known as the maximum achievable yield. Farm level yield is the average farmer's yield within a specific environment at a specific time and place. The yield gap consists of two parts. Because the first component is mostly caused by non-transferable elements like environmental conditions, it cannot be narrowed down or exploited. The primary cause of the second component is variations in management techniques.

Rice being one of the most important crops of Chandel district and is cultivated both in Jhum lands and in low lands. However, the production and productivity are very lowdue to less adoption of HYV rice varieties by the farmers.In the recent past ICAR-KVK Chandel came up with worthwhile production technologies and demonstration of HYV Rice var. RC-Maniphou-13. However, such technological benefits are not yet harnessed by the farmers. Therefore, yield level of farmers practice (Local varieties) is quite low than that is achieved in demonstration plots. Therefore, the present investigation was carried out to estimate the yield gaps in Rice for havingplanning for better research and extension.

MATERIAL AND METHODS

The study was conducted in the farmers' field located in Chandel district by ICAR-KVK Chandel during *Kharif seasons* of 2018, 2019,2020, 2021 and 2022 in92 farmers' field for 40 hectares of land. Scientific package of practices like seed treatment, nutrient management, proper spacing, adequate seed rate etc were used in the demonstrations and Rice seed variety RC-Maniphou-13 was taken under Front Line Demonstrations. In general, soils of the area under study were clay loam and medium to low in fertility status rich in organic matter. The Rice seedlings were transplanted at 20 days after sowing with the spacing of 20 cm x 20 cm to ensure recommended plant population. Sowing was done during last week of June to first week of July. The yield data and economics from both the demonstration and farmers practice (Local variety Drum Phou) were recorded and their technology gap, extension gap and the technology index were calculated with the techniques provided by Samui et al.(2000) and Meena and Dudi, (2018) as stated below:

Tech. gap = Potential yield – Demo. Plot yield

Ext. gap = Demo. Plot yield – Farmer's plot yield

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

Where

Pi= Potential yield; Di= Demonstration yield

Yield gap analysis: Yield gap have been calculated on the basis of per hectare potential farm yield and actual farm yield using simple statistical tools as follows:

Potential farm yield minus Actual farm produced is the Yield gap.Singh and Feroze (2017).

Under rainfed ecologies, the improved rice variety RC-Maniphou-13 now being popularized have been chosen as the standard varieties and their potential assessed from their performance in the compact block Frontline Demonstrations (FLD). Mean FLD yield in a given 5 years period was taken as the Demonstration yield and that of the check local variety Drumphou as actual farmers' yield. Yield difference in percentage between FLD yield and local rice variety yield was taken as the yield gap.

RESULTS AND DISCUSSION

Table 1. Details of improved package and farmers practice

Particulars	Improved package	Farmers practices (Local check)
Variety	RC-Maniphou-13	Drum phou
Seedling age	20 days	30-35days
Spacing	20 cm x 20 cm	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 insecticides & fungicides spray	No insecticides & fungicides spray

Table 2. Productivity, technology gap, extension gap and technology index in Rice var. RC-Maniphou-13 under FLDs

Year	Area(Ha)	No. of farmers	Grain Yield(q/ha)			% increase over control	Tech gap /Yield Gap (q/ha)	Ext. gap (q/ha)	Tech. index %
			P	D	FP				
2018	5	11	70.00	57.60	42.50	35.53	12.40	15.10	17.71
2019	5	14	70.00	58.15	43.86	32.58	11.85	14.29	16.93
2020	10	22	70.00	58.95	44.35	32.92	11.05	14.60	15.79
2021	10	20	70.00	59.48	45.15	31.74	10.52	14.33	15.03
2022	10	25	70.00	60.60	47.33	28.04	9.40	13.27	13.43
Total	**40**	**92**							
Average			**70**	**58.96**	**44.36**	**32.16**	**11.04**	**14.32**	**15.78**

P= Potential D= Demonstration FP= Farmers' practice

Table 3:Economicsof Rice var. RC-Maniphou-13 under FLD and Farmer practise var. Drum Phou

Year	Cost of cultivation (₹ /ha)		Gross return (₹ /ha)		Net return (₹ /ha)		B:C ratio	
	Demonstration	Farmers practise	Demonstration	Farmers practise	Demonstration	Farmers practise	Demonstration	Farmers practise
2018	55498	58700	86400	63750	30902	5050	1.56	1.09
2019	57500	61500	104670	78948	47170	17448	1.82	1.28
2020	59590	65500	117900	88700	58310	23200	1.98	1.35
2021	62350	67200	118960	90300	56610	23100	1.91	1.34
2022	64150	69450	169680	132524	105530	63074	2.65	1.91
Average	**59817.60**	**64470.00**	**119522.00**	**89724.40**	**59704.40**	**25254.40**	**1.98**	**1.38**

Grain Yield

The performance of Rice var. RC-Maniphou-13 during the five years of front line demonstrations revealed that maximum grain yield of 60.60 q/ha was recorded during 2022 and minimum grain yield of 57.60 q/ha during 2018 respectively and the mean grain yield of 58.96 q/ha were recorded in all the five years under demonstrated plots which was higher over local check 44.24 q/ha. On an average there was increased in the yield by 33.29 % over local check (Table 2). This clearly indicates the positive impact of front line demonstration with improved technology. The findings were also in close conformity with the findings of AK Singha et al. 2020

Yield gaps

Yield of Rice var. RC-Maniphou-13 under demonstration and farmers'var. Drum-phouwas compared to estimate the yield gap during the years of demonstrations (2018 to 2022). It has been observed that the Yield gap/technology gapranges from 9.40to 12.40 q/ ha during the years ofinvestigation. The highest technological gap was obtained during 2018 (12.40 q/ha) while lowest gap was observed during 2022 (9.40 kg/ha). "The technology index showed the feasibility of the evolved technology at the farmers' field. The lower the value of technology index more is the feasibility of technology"(Singh et al., 2007)."The higher technology gap may be attributed due to improper distribution of rainfall, variation in soil fertility status, non-congenial weather conditions and local specific crop management problems faced in order to obtain the yield potential of specific crop cultivars”Ahmad *et al*., (2013). The technology and extension gap can be addressed by popularizing a set of practices that emphasize improved varieties, proper seed rate, balanced nutrient delivery, and proper use of plant protection measures.

Extension gaps

The greatest extension gap, 15.10 q/ha, was noted in 2018, followed by 14.60 q/ha in 2020, and the lowest, 13.27 q/ha, in 2022. This highlighted the necessity of educating farmers through a wide range of methods to encourage the adoption of better agricultural production methods and stop the current trend of a large extension gap. Using the most recent production technologies and high-yielding varieties will thereby reverse the alarming pattern of the increasing extension gap. The new technologies will eventually lead the farmers to discontinue the old technology and to adopt new technology. This finding is in agreementwith the findings of Chongloi and Singh, 2022.

Technology Index

The data of the technology index (Table 2) showed the feasibility of the evolved technology at the farmers’ field. The technology is more feasible when its technology index values are lowest. The lowest technology index 13.43% was recorded during 2022 and highest of 17.71% was recorded during 2018. This indicate that a strong gap exist between the generated technology at the research institution and disseminated at the farmers’ field. But the introduction of HYVs and demonstration of improved technology followed by intensive awareness campaign will eventually lead to adoption of generated technology among farmers of the district to accelerate production and productivity enhancement in the rice cultivation.

Economic analysis

The prices of the commodities prevailed during the study of demonstrations were taken for calculating the economics. The economic analysis of the data (Table 3) during the study period for rice clearly revealed that the gross return, net returns and benefit: cost ratios were higher in frontline demonstrations, where recommended practices were followed as compared to farmers’ practice indicating higher profitability. The benefit cost ratios under demonstration plots were 1.56, 1.82, 1.98, 1.91 and 2.65during 2018, 2019, 2020, 2021 and 2022 respectively which were higher than the local check. This may be due to higher yields obtained under improved technologies as compared to farmers practice (local rice var. Drum-phou).

CONCLUSION

Performance of rice var. RC-Maniphou-13 underFront Line Demonstration adhering to recommended agronomic practicescontributes to yield gain and income and reduces the yield gap. The average yield increase of 32.16 % over farmer's practices was observed during the five years of demonstrations**.** From the above findings, it can also be concluded that integration of improved production technology with HYV seeds of rice performed better than local check and can reduce the technology index to a considerable extent thus leading to increased productivity of rice in the district. Scientific cultivation practices with improve variety seeds could help in improving rice productivity and profitability. Favourable benefit cost ratio itself is an explanatory of economic viability of the demonstration and convinced the farmers for adoption of intervention imparted.Replacement of variety with newly released variety will increase the production and net income. Recommended technology was found to be suitable since it fits well to the existing farming situation and also it had been appreciated by the farmers.

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