Research Article
Journal of Extension Education
Vol. 33 No.1, 2021
DOI: https://doi.org/10.26725/JEE.2021.1.33.6549-6557

Factors affecting Yield Gap of Rice in North Kerala

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ABSTRACT

Yield gap is an important indicator for any crop. Rice being the staple food, in order to meet the increased demand of rice juxtaposed with an increasing population growth, it becomes important to study the factors affecting yield gap that will emerge as the most significant solution, which in turn serves to bridge the yield gap. This study was conducted in 7 districts of Kerala during the year 2020-2021 to find out the factors affecting the yield gap of rice. Altogether, 105 rice farmers from the districts of Kasaragod, Kannur, Wayanad, Kozhikode, Malappuram, Thrissur formed the sample. Ex-post facto research design was used for the study. The yield gap index derived from the study ranged from 10 to 30 per cent. The results of the Principal Component Analysis revealed that five components namely climatic factors, biological factors, socio-economic factors, institutional/policy related factors and factors related to technology transfer were critically influencing the yield gap of rice.

Keywords: *Yield gap; Rice; Farmers; Adoption; Kerala; Biological factor*

INTRODUCTION

Rice is the staple food crop of Kerala. The heritage of rice cultivation in Kerala is way ahead from 3000 B.C (Manilal, 1991; Kumar and Kunhamu, 2021). It is a widely cultivated yet "scarce" subsistence crop. The drastic shrinkage of area and production of rice due to the shift from paddy cultivation towards less water requiring crops such as oilseeds, pulses, coarse cereals, nutri cereals, cotton, etc. shows the steady decline in cultivation of rice (Economic Survey, 2022). Yearly consumption of rice in Kerala accounts to about 40 lakh tonnes out of which *Jaya* and *Surekha* rice from Andhra Pradesh makes up to 22 lakh tonnes of consumption (Varma, 2017). The deficit in production to

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Received : 07-11-2021 **Accepted:** 26-04-2022

consumption of rice is exactly the significance of this study and where the yield gap attribute pronounces its existence.

Yield gap in rice *i.e.* the difference between the potential yield and the yield obtained by the farmer in his field stands as a valuable performance indicator for the rice production in the country. Yield gap in crops is a real challenge which needs to be addressed in the interest of enhanced, sustainable production of crops. Yield gap analysis thus, will offer opportunity to improve production, improve infrastructure and policy requirements that will create jobs, increase productive capacity of the people and the agricultural industry. It will show their shortfalls and help to take corrective measures necessary to improve production, profitability and renewed interest in rice cultivation. In order to ensure that real potential of any crop variety is harvested at the cultivator's field, yield gap is always a prime concern for researcher as well as developmental stakeholders. A gap always sustains between potential yield, demonstration yield and what is harvested from a farmer's field. Environmental factors, socio-economic factors and non-adoption of recommended package of practices by farmers can be the reasons for the yield gap of rice (Subba and Subramanyam, 1987). Finding the factors affecting yield gap has prime importance in bridging the existing yield gap.

METHODOLOGY

The rice growing tracts of northern districts of the State of Kerala, *viz*., Kasaragod, Kannur, Kozhikode, Wayanad, Palakkad, Thrissur and Malappuram were selected for the study. *Ex-post facto* research design was employed. In consultation with the Principal Agricultural Office (PAO) of the district, the *panchayat* having maximum rice area under cultivation was selected. From the selected *panchayat*, 15 farmers each having a minimum of 50 cents (0.2 ha) were chosen. Thus, simple random sampling technique was employed for selecting the 105 farmers from the seven districts with 15 farmers each from the respective *panchayat* selected for the study. Responses were collected from the rice farmers by employing survey method using a well-structured pre tested interview schedule.

Yield gap was the dependent variable of the study. Yield gap of the varieties cultivated by the rice farmers was calculated by finding the difference between Maximum Potential Yield (MPY) and the Actual Yield (AY) obtained by the farmers. The Yield Gap Index (YGI) was calculated using the formulae:

$$YGI = [YG/YP] \times 100\%,$$

$$YG = YP - YA$$

Where,

YG=Yield Gap,

YP= Yield Potential,

YA= Yield Attained.

Age, sex, education, farming experience, area under rice cultivation, income from agriculture, income from paddy cultivation, trainings received, economic motivation, innovativeness, scientific orientation, market orientation, extension orientation, level of awareness and knowledge were the independent variables selected for the study. The major factors affecting yield gap along with sub components under each factor were enumerated after careful review of literature and discussion with experts. They were biological factors, socio-economic factors, climatic factors, institutional/government policy related factors and factors promoting technology transfer (RAP, 2000). The factors were administered to the rice farmers and ranked from 1 to 5 based on their importance in affecting yield gap. Principal Component Analysis was done in order to find the most important factors that affects yield gap of rice.

FINDINGS AND DISCUSSION

Major rice Varieties Cultivated by the Farmers of North Kerala

The state of Kerala has around 2000 traditional rice varieties (Kumari, 2012) which are adapted to a wide range of agro-ecological situations. This includes specialty rice varieties that denote to the diverse collection of traditional rice varieties that are conserved and cultivated. However, farmers cultivate released high yielding varieties for better productivity. Hence, an attempt was made to understand the major rice varieties grown by rice farmers at large. It is evident from Table 1 that majority of the farmers *i.e.*, 96.19 per cent was cultivating *Uma* rice variety. *Jyothi* rice variety was cultivated by 17.14 per cent of the farmers whereas *Jaya* rice variety was cultivated by 2.86 per cent farmers. Some of the farmers were cultivating more than one rice variety.

The preference for high yielding varieties by farmers are a result of economic motives and hence, *Uma* variety might have been preferred by the farmers. The yield gap data in Table 2 is an indicator where from the popularly grown two varieties viz., *Uma* and *Jyothi*, the yield gap index of *Uma* rice variety was less than that of those farmers cultivating *Jyothi* rice variety. Subsistence farmers may adopt growing traditional varieties of rice only enough to meet the requirements of their household. It is observed that many of these farmers use traditional rice varieties. The researcher also noted that at least few farmers in districts like Wayanad are gradually returning to traditional rice for its conservation importance, better taste, requiring less care and non-requirement of toxic chemicals. Many among them grow traditional varieties for their personal consumption or for the taste preferences of special markets. The reasons for the continued cultivation of traditional varieties on some rainfed areas are disadvantages during drought and flood (Umezuruike and Francois, 2001).

Table 1.
Varieties of Rice Cultivated by the Farmers of North Kerala

n=105

Sl.No	Variety	No. of farmers adopting	Percentage
1	UMA	101	96.19
2	JYOTHI	18	17.14
3	NAVARA	1	0.95
4	KANCHANA	1	0.95
5	ASD 16	1	0.95
6	MANURATNA	1	0.95
7	JAYA	3	2.86
8	RAKTHASALI	1	0.95
9	GANDHAKASALA	1	0.95
10	JEERAKASALA	1	0.95
11	MITHILA	1	0.95
12	EZHOME-1	2	1.90
13	EZHOME-2	2	1.90

Yield Gap of The Rice Varieties Cultivated by Farmers and Factors affecting Yield Gap

The knowledge about crop yield gap at district, state, national or international level will help in identifying management strategies for sustainable agricultural production to meet future food demand. Yield gap analysis can provide a foundation for detecting the best management approaches to improve the rainfed rice yield by reducing the gap from the potential yield. Boling et al., (2011); Alam et al., (2013); and Stuart et al., (2016) emphasized the possibilities of increasing rice yields by reducing the yield gap in rice-based farming systems. The yield gap of the rice varieties measured in terms of yield gap

Table 2.
Yield Gap and Yield Gap Index of the Rice Varieties Cultivated by Farmers

Sl.No	Variety	Yield Gap (t/ha)	Yield Gap Index (%)
1	JYOTHI	2.39	29.86
2	KANCHANA	2.00	28.57
3	NAVARA	0.13	25.00
4	ASD16	1.50	25.00
5	RAKTHASALI	1.00	25.00

Sl.No	Variety	Yield Gap (t/ha)	Yield Gap Index (%)
6	MITHILA	1.50	25.00
7	UMA	1.64	20.47
8	JEERAKASALA	0.45	16.67
9	JAYA	0.75	12.50
10	EZHOME-2	0.39	12.11
11	GANDHAKASALA	0.30	10.71
12	EZHOME-1	0.38	10.71
13	MANURATNA	0.50	8.33

Table 2 reveals that the yield gap index of *Jyothi* was the highest among the varieties cultivated which is 29.86 per cent. *Kanchana* variety has a yield gap index of 28.57 per cent. *Navara*, ASD 16 and *Rakthasali* varieties exhibit a yield gap index of 25 per cent. The least yield gap index is shown by *Manuratna* variety which is 8.33 per cent. The yield gap of varieties namely *Jyothi* and *Kanchana* which is closely around 30 % can be attributed to the difference in spacing followed by the farmers in their fields, soil characteristics, management practices followed, disease and pest attacks etc. Climatic factors can also influence the crop yield to a great extent as grain shattering caused by mild to moderate winds or rains leads to grain loss.

An attempt was made to delineate the factors affecting yield gap of paddy varieties. The results are presented in Fig. 1 and Tables 3 & 4. From Figure 1 it is clear that 36.2 per cent of the variance is contributed by the component 1 followed by 23.5 per cent by component 2, 17 per cent by component 3, 12.4 per cent by component 4 and 10.8 per cent by component 5.

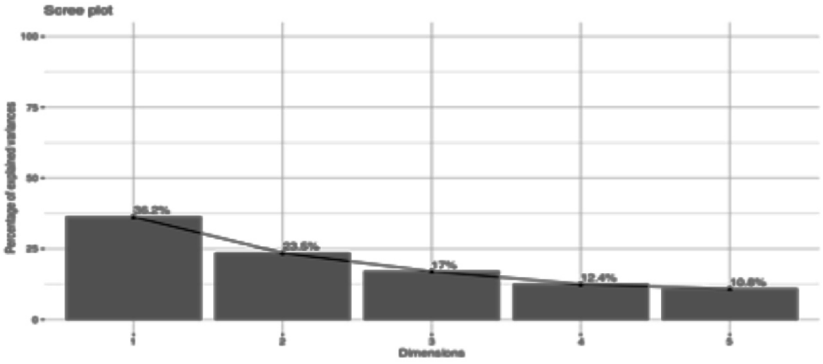

Figure 1: Variance of the Components as Scree plot

It is evident from the Figure 1 and Table 3 that first 3 components viz., climatic factors, biological factors and socio-economic factors contribute more than 75 per cent of the variance.

Table 3.
Total Variance of the Components of Factors affecting Yield Gap

Principal component	Eigen value	Percentage of variance	Cumulative percentage of variance
PC1 - Cf	1.812	36.247	36.247
PC2 - Bf	1.174	23.488	59.736
PC3- Sef	0.850	16.998	76.734
PC4 - Ipf	0.622	12.444	89.178
PC5- Ttf	0.541	10.822	100.000

Table 4.
Correlation between Variables and PCs

Sl.No.	Variables	PC1	PC2	PC3	PC4	PC5
1.	Climatic Factors (Cf)	0.45	0.448	0.750	-0.183	-0.033
2.	Biological Factors (Bf)	0.701	0.164	-0.442	-0.472	-0.253
3.	Socio-economic Factors (Sef)	0.240	0.830	-0.296	0.344	0.220
4.	Institutional or Policy Factors (Ipf)	0.735	-0.294	0.061	0.496	-0.352
5.	Technology Transfer Related Factors (Ttf)	0.722	-0.415	-0.001	-0.048	0.551

Table 4 reveals that after the PCA analysis, all the five components viz., climatic factors, biological factors, socio-economic factors, institutional/policy related factors and factors related to technology transfer were the influencing yield gap. From the first component institutional/policy related factors show high correlation value of 0.735 followed by Factors related to technology transfer (0.722) and biological factors (0.701). Socio-economic factors show highest correlation from the second component with a value of 0.83. From the third component climatic factors has high correlation value of 0.75. Institutional/policy related factors from the fourth component shows highest correlation having value 0.496. Factors related to technology transfer shows highest correlation value of 0.551 from the

fifth component. From the above values it is clear that all the components affect the yield gap of rice.

Climatic factors affect the yield gap predominantly which can be either predicted or unpredicted. Flash floods have affected the paddy cultivation to a great extent in recent years. Regular monitoring and accurate predictions of weather and climate parameters can help the farmers a lot to harvest their year-round investments and hard work in better returns. We could find that climate and variety became the most important factors limiting improvement of rice yield, through specific analysis, making the breeding researches cautious to cultivate much more novel varieties with stronger adaptability to the complex environment (Ran et. al., 2018). Much of the apparent gap between yields on research stations and farmer's yields can be attributed to bio-physical factors, including floods, soil-based issues, insect damages, diseases etc (Lobell et. al., 2009).

Integrated Crop Management (ICM) can effectively address yield gaps induced by biological, socio-economic, and institutional constraints (Mondal, 2011). Government should find solutions to socio-economic and political questions for narrowing the yield gap between farmers' fields and the research stations (Hanson et al., 1982). Rapid progress and augmented rate of obsolescence of technologies entail technology forecasting for any planning process (Thomas and Kumar, 2015). Usage of High Yielding Varieties along with latest production technologies will subsequently alter the alarming hike in yield gap. This finding is in accordance with the study of Joshi et al., (2014), Kumar et al., (2014) and Kulkarni et al., (2018).

CONCLUSION

Yield gap is an issue to be dealt with seriously taking the subsistence needs of mankind into consideration. From this study it was evident that 13 rice varieties are commercially cultivated by the farmers, in general of which *Uma* variety is the most popular rice variety cultivated by farmers. However, *Jyothi* variety has the highest yield gap, followed by *Kanchana* rice variety. Reduced yield gap can certainly feed more stomachs. A good understanding about the factors affecting yield gap can make a great difference in ensuring food security. It is also evident that climatic factors, biological factors and socio-economic factors contribute more than 75 per cent of the variance. Regular check of pests and diseases and field management should be given importance which also has much influence. A farmer- friendly policy should be ensured for the rice farmers to realize maximum productivity by way of tackling issues related to yield gap which will help farmers to remain motivated to continue rice production. Extension services should

be re-oriented to boost the socio-economic status of the rice farmers with more incentives, especially during times of distress due to climate related anomalies like untimely rain or drought.

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