Journal of AgriSearch 2(4): 273-276
Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)

Yield Gap Analysis of Hybrid Rice: A Case Study in Kalyanpur Block of Samastipur District (Bihar)

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ARTICLE INFO

Received on	: 04.11.2015
Accepted on	: 23.11.2015
Published online	: 07.12.2015

ABSTRACT

The study based on primary as well as secondary data was carried out in four selected villages namely, Somnaha, Simria Bhindi, Kharsand and Madhurapur of Kalyanpur block of Samastipur district in Bihar. Primary data were collected from a sample of 60 farmers spread over the study area, constituting 20 marginal, 15 small and 25 big farmers who were selected using probability proportional to size method (PPS) for the study. The total Yield Gap in rice production was worked out as the summation of Yield Gap I (YG-I) and Yield Gap-II (YG-II), which was estimated as 47.02 q/ha on big size, 54.97 q/ha on small size and 62.9 q/ha on marginal size farms and on an average, it was 54.30 q/ha. On the whole, the estimated value of Index of Realized Potential Farm Yield (IRPFY) was found to be 88.68 per cent, whereas the Index of Realized Potential Yield (IRPY) was observed as 48.29 per cent. An overall Index of Yield Gap was estimated as 51.70 per cent. It may be inferred from the study that the proper utilization of recommended package and practices of hybrid rice along with the supply of quality inputs viz. seeds, fertilizers, irrigation and plant protection measures on different categories of farms may help reduce the yield gap of the crop on the one hand and raise the income of the cultivators on the other.

Keywords: Bihar, Hybrid rice, Yield gap

INTRODUCTION

Rice is a staple food crop and it constitutes over half of the cereals consumption of the country (Bharati *et al.*, 2014; Ali, 2008). It contributed 95.32 million tonnes (39.46 percent) of the total food grain production (241.56 million tonnes) in the country in 2010-11 (Singh *et al.*, 2014). India stands first in paddy area with over 43 million hectares and second in its production. In spite of dietary diversification and shift of consumers' preferences towards horticultural and livestock products, rice is playing a seminal role in food security of the country as it is a rich source of energy (Singh and Singh, 2000). The total domestic demand for rice is estimated to be 113.3 million tonnes and requires 28-29% yield enhancement to achieve 2.65 tonnes per hectare average yield for the year 2021-22 (Kumar *et al.*, 2009). As considering the fact that there is no scope for area expansion under rice cultivation, Government of India launched 'National Food Security Mission' in 2007-08 comprising rice, wheat and pulses to increase the production of 10 million tonnes and 8 million tonnes and 2 million tonnes, respectively by the end of Eleventh Plan (2011-12). Notwithstanding the fact that technological breakthrough in the field of agriculture has resulted in increased crop productivity, trials and demonstrations are conducted to test feasibility and suitability of new technologies before releasing them for adoption on farmers' field, the crop yield realized on the farmers' field are considerably lower than that recorded on the demonstration plot (Chaudhary 2000; Ali, 2008). It was felt that as a step towards narrowing down the yield gap between the farmers' field and the demonstration plots, there was a need to take up in-depth analysis of yield (Chavan *et al.*, 2008; Fale, *et al.*, 1985; Gaddi, and Mundinamani, 2002; Gaddi, *et al.*, 2002). The objectives of the study were: To estimate the yield gap with respect to hybrid rice production and to measure the gap between recommended package of practices and actual farmers' practices with respect to hybrid rice production.

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MATERIALS AND METHODS

The study is based on both primary as well as secondary data. Samastipur district was purposively selected for the study on account of low productivity of rice in the district. Out of 20 blocks in the district, Kalyanpur block was selected based on the larger area under rice. Further four villages, namely Somnaha, Simria Bhindi, Kharsand and Madhurapur were selected in the same manner. A sample of 60 farmers, constituting 20 marginal, 15 small and 25 big farmers was selected by using probability proportional to size method (PPS).

Yield gap and indices of yield gap

Yield gap was estimated using methodology developed by the International Rice Research Institute (IRRI) Manila, Philippines. Potential yield (Y_P) is defined as the per hectare crop yield realized on the research station. Potential Farm Yield (Y_d)/ Progressive farmers' yield (Y_d) is the highest yield obtained by a farmer in a farm size category and the Actual Yield (Y_a) is defined as per hectare yield realized by the farmers on their field. The Total Yield Gap (TYG) is computed as the difference between the Potential Yield (Y_P) and the Actual Yield (Y_a) (Eq.1).

$$\mathbf{TYG = Y_P - Y_a} \qquad \text{[Eq.1]}$$

The Total Yield Gap comprises of Yield Gap I and Yield Gap II.

Yield Gap I (YG I): It is the difference between the Potential Yield (Y_P) and Progressive Farmers' yield (Y_d) (Eq.2).

$$\mathbf{YG\ I = Y_P - Y_d} \qquad \text{[Eq.2]}$$

Yield Gap II (YG II) : It is the difference between the Progressive farmer's yield/ Potential Farm Yield (Y_d) and the Actual Yield (Y_a) (Eq.3).

$$\mathbf{YG\ II = (Y_d - Y_a)} \qquad \text{[Eq.3]}$$

Index of Yield Gap (IYG) : It is the ratio of the difference between the Potential Yield (Y_P) and the Actual Yield (Y_a) to the Potential Yield (Y_P) expressed in percentage (Eq.4)

$$\mathbf{IYG = [Y_P - Y_a/Y_P] \times 100} \qquad \text{[Eq.4]}$$

Index of Realized Potential Yield (IRPY)

$$\mathbf{IRPY = [Y_a/Y_P] \times 100} \qquad \text{[Eq.5]}$$

Where,

Y_a = Actual yield
Y_P = Potential yield

Index of Realized Potential Farm Yield (IRPFY)

$$\mathbf{IRPFY = [Y_a/Y_d] \times 100} \qquad \text{[Eq.6]}$$

Where,

Y_a = Actual yield
Y_P = Potential yield

RESULTS AND DISCUSSION

The analysis revealed that though the yield gap of 47.02q/ha on big farms was quite high. However, on comparison with other farm size-groups, the yield gap was observed comparatively low on big farms (Table 1) which may probably be due to their better management of farms or their better economic condition which enabled them to use more inputs required for hybrid paddy cultivation .For in-depth study, the Total Yield Gap was split into two components, viz. Yield Gap–I and Yield Gap–II. Yield Gap-I was observed to be as high as 52.70q/ha on marginal farms followed by 49.84 q/ha and 42.72 q/ha for small and big farms, respectively. Yield Gap-II was found to be 10.2 q/ha on marginal farms, whereas 5.13 q/ha and 4.3 q/ha on small and big farms, respectively. It was evident that yield gap decreased as the farm size increased showing inverse relationship between yield gap and farm size. The higher magnitude of Yield Gap-I may probably be attributed to the non-transferable component of technology such as cultural practices like differences in taking up of agronomical practices such as time of preparation of land, maintenance of proper plant spacing and plant density, application of chemical fertilizers and plant

Table 1: Yield gap in hybrid rice (Arize-6444) on sample farms (Yield q/ha)

Farm size group	Potential yield	Progressive farmers' yield	Yield Gap I (YG-I)	Actual farmers' yield	Yield Gap II (YG-II)	Total Yield Gap (YG-I + YG-II)
Marginal	105	52.30	52.70	42.10	10.2	62.9
Small	105	55.16	49.84	50.03	5.13	54.97
Big	105	62.28	42.72	57.98	4.3	47.02
Overall	105	57.18	47.82	50.71	6.47	54.30

protection materials and water in appropriate doses between the research station and farmers' field.

Indices of yield gap

It may be observed that, on an average, the estimated value of Index of realised potential farm yield was worked out as 88.68 as compared to overall Index of realized potential yield (48.29). However, the farm size wise IRPY (Index of realized potential yield) analysis revealed that it was highest on big farms being 55.22 percent and the lowest on marginal farms with 40.09 percent, indicating that increment in yield may be made to the level of 44.78 and 59.91 percent, respectively (Table 2).

Table 2: Indices of yield gap in hybrid rice (Arize 6444) on sample farms

Farm size	Index of Realized Potential Yield (IRPY)	Index of Realized Potential Farm Yield (IRPFY)	Index of Yield Gap (IYG) (%)
Marginal	40.09	80.49	59.90
Small	47.64	90.70	52.35
Big	55.22	93.09	44.78
Overall	48.29	88.68	51.70

Gap between recommended practices and actual farmers' practices

The input gap in question has been obtained by deducting the amount of inputs used at the farmers' field from the respective amount of the inputs used at the research station (Gavali *et al.*, 2011). It is evident that overall gap of nitrogen, phosphorus and potassium used by the paddy growers in the study area was 23.93 kg/ha, 18.86 kg/ha and 23.4 kg/ha, respectively (Table 3). It is lower than the prescribed/recommended doses. The gap in the use of nitrogen in comparison with the recommended doses in case of rice was 39.8 kg/ha, 27.3 kg/ha and 9.2 kg/ha on marginal, small and big farms, respectively. Comparatively larger gap was observed in case of nitrogen application to that of small and big farms. The gap in the use of phosphorus in rice cultivation was estimated to be 29.6 kg/ha,19.4kg/ha and 9.94 kg/ha on marginal, small and big farms, respectively. Further, in case of potassic fertilizers in rice crop, it was calculated as 37.1 kg/ha, 24.2kg/ha, and 11.95 kg/ha on marginal, small and big size of farms, respectively. Better economic status of larger farmers may be the reason for such an observation. Further more, it was observed that plant protection materials were used in excess of recommended doses. It may probably be on account of lack of awareness on the part of rice growers about ill effects of plant protection chemicals on human and animal health and soil micro-organisms (Singh *et al.*, 2014).

Technological breakthrough in the field of agriculture has resulted in increased crop productivity; however, the crop yields realized on the farmers' field are considerably lower than that recorded on the demonstration plot (Job, 2006; Kurmi and Bhowmick, 1991). Study revealed that the yield gap decreases with increase in the farm size, showing an inverse relationship between yield gap and farm size. The higher yield gap may be attributed to the non-transferable component of technology such

Table 3: Level of material input use in hybrid rice (Arize-6444)

Particular	Recommended dose	Marginal farms		Small farms		Big farms		Overall	
		Actual input use	Gap	Actual input use	Gap	Actual input use	Gap	Actual input use	Gap
Seed (kg/ha)	15	14.02	0.98 (6.5)	14.12	0.88 (5.86)	13.58	1.42 (9.46)	13.86	1.14 (7.60)
Nitrogen (kg/ha)	120	80.20	39.80 (33.16)	92.70	27.30 (22.75)	110.80	9.20 (7.67)	97.07	23.93 (19.94)
Phosphorus (kg/ha)	60	30.40	29.60 (49.33)	40.60	19.40 (32.33)	50.06	9.94 (16.57)	41.14	18.86 (31.43)
Potassium (kg/ha)	60	22.90	37.10 (61.83)	35.80	24.20 (40.33)	48.05	11.95 (19.91)	36.60	23.40 (39.0)
Plant Protection (Rs/ha)	2876	3459.00	-583.00 (-20.27)	3178.00	-302.00 (-10.50)	3336.00	-460.00 (-15.99)	3337.00	-461.00 (-16.04)
Irrigation (Rs/ha)	8000	6200.00	1800.00 (22.50)	7000.00	1000.00 (12.50)	7400.00	600.00 (7.50)	6900.00	1100.00 (13.75)

Note: Figures in the parentheses indicate gap percentage.

as cultural practices like differences in taking up of agronomical practices such as time of preparation of land, maintenance of proper plant spacing and plant density, application of chemical fertilizers and plant protection materials and water in appropriate doses between the research station and farmers' field (Raju *et al*., 1996; Reddy, 1997; Sahu *et al*., 1993; Sananse, and Vichare, 2007). On an average, the total yield gap of hybrid rice (Arize 6444) was estimated to be 54.30 q/ha. The yield gap may also be attributed to the gap in inputs use between the recommended package and practices as well as farmers' practices.

CONCLUSIONS

On an average, the total yield gap of hybrid rice (Arize 6444) was estimated to be 54.30 q/ha. The yield gap may also be attributed to the gap in inputs use between the recommended package and practices as well as farmers' practices. To minimize the yield gap, some measures like, provision of assured electricity supply, subsidized diesel for irrigation, expansion of surface irrigation (Canal as low cost irrigation method), effective credit facility, effective implementation of crop insurance scheme as well as minimum support prices, along with arrangement for supply of quality seed, fertilizers, insecticides and pesticides etc. to farmers on time are required (Singh and Kumar 2000; Swathi, and Chandrakandan, 2006). They would also require effective extension services to enable them to use recommended level of inputs (Singh, 2010).

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Citation:

Kumar A, Sinha DK, Mishra RR, Ahmad N and Singh KM.2015.Yield gap analysis of hybrid rice: A case study in Kalyanpur block of Samastipur district (Bihar). *Journal of AgriSearch* **2** (4): 273-276