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Understanding Yield Gaps in Food Grains – A Study on Yield Gaps in Paddy Cultivation

Preethika D. T.[1*] and Amrutha T. Joshi[2]

[1]Research Associate, Institute for Social and Economic Change, Bangalore

[2] Professor, University of Agricultural Sciences, Raichur

*Corresponding Author E-mail: pritikaprabhu92@gmail.com

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ABSTRACT

Production of food grains in India increased considerably since 1960s due to the increase in arable area. The food security of India is, however, now at risk due to increase in population. By 2050, India's population is expected to grow to 1.60 billion from the current level of 1.10 billion. This implies a greater demand for food. With rice being the most important food of India, its important to improve the productivity levels of rice. Rice is grown on an area of about 43 million hectare in India accounting for about 20 per cent of the total cropped area with the production of 104.32 MT during 2013. It is projected that India needs to produce 115 MT of rice by the year 2020 to maintain the present level of self-sufficiency. The future increase in rice production requires improvement in productivity and productivity efficiency. Yield gap analysis of paddy from Raichur district of Karnataka indicated that the yield realised at the experimental station was 70 quintals per ha and the potential farm yield was found to be 65 quintals per ha with the yield gap of 7.14 per cent (5 q/ha) Among the different categories of farmers, large farmers have realised highest yield of 66.5 quintals per ha followed by medium (64.75 q/ha) and small farmers (63 q/ha). The yield gap appears minimal in the study region as the region is resource abundant. However its crucial to explore yield gaps in paddy, in the other resource constraint regions of the state.

Key words: *Food grains, Yield, Food, Paddy*

INTRODUCTION

Global agriculture will face multiple challenges in the coming decades. It must produce more food to feed an increasingly affluent and growing world population that will demand a more diverse diet, contribute to overall development and poverty alleviation in many developing countries, confront increased competition for alternative uses of finite land and water resources, adapt to climate change, and contribute to preserving biodiversity and restoring fragile ecosystems. Addressing these challenges requires co-ordinated responses from the public and private sectors and civil society that will need to be adapted to the specific circumstances of different types of farmers in countries at all levels of development.

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Of a total global land area of 13,000 million ha, arable land and permanent crops account for 12 per cent, permanent meadows and pastures for 26 per cent, forests for 30 per cent, whereas 32 per cent of this land is unsuitable for agriculture. Globally, 15 per cent of arable land is irrigated and currently accounts for 42 per cent of all crop production; 7100 km^3 of water is consumed annually to produce food globally whereas feeding the world population of around 9 billion by 2050 would require an additional 2100 km^3 $year^{1,2}$.

The production of food grains in India increased considerably since 1960s due to increase in arable area, large-scale cultivation of high yielding semi-dwarf varieties and increased applications of irrigation, fertilizers and pesticides. India became food secure in the last three decades, at gross level, because of increase in food production. The food security of India and other countries in South Asia is, however, now at risk due to increase in population. By 2050, India's population is expected to grow to 1.60 billion people from the current level of 1.10 billion. This implies a greater demand for food. Although, the world as a whole may have sufficient food for everyone, it would need to be produced in the region itself due to socio-economic and political compulsions[3]. The cereal requirement of India by 2020 will be between 257 and 296 million tons depending on income growth[4]. The demand for rice and wheat is expected to increase to 122 and 103 million tonnes, respectively, by 2020 assuming a medium income growth[5]. This will have to be produced from the same or even shrinking land resource. Thus, by 2020 the average yields of rice and wheat need to be increased by about 60 per cent. Similar is the scenario for many other crops.

The role of technological development in agriculture boom is well recognised. However, it is seen that the performance of technology in farmers' fields is not satisfactory. The national average of crop yields continue to be well below the practicable potential yields. Yield gap analysis is a formal methodology that arised during 1970's developed by International Rice Research Institute, it was extensively used to measure and analyse the determinants of yield gaps in farmers' fields. The findings of yield gap analysis have many implications for policy formulation aimed at alleviating the constraints causing yield gaps. The results can also be used by the researchers to modify technology so as to reduce yield gaps.

Rice is the major cereal crops in India contributing significantly to the nation's food and nutritional security. Paddy has an extensive range of cultivation. It occupies not only the tropics but also extends far into the temperate zone. It is an Asiatic food crop. Southern, South-Eastern Asia forms the largest paddy growing part of the globe and the largest consuming population also belongs to this area.

Rice is grown on an area of about 43 million hectare in India accounting for about 20 per cent of the total cropped area with the production of 104.32 MT during 2013. It is projected that India needs to produce 115 MT of rice by the year 2020 to maintain the present level of self-sufficiency. The area under rice in Karnataka was 14.16 lakh hectares during 2013 with the total production of 39.55 lakh tonnes and the productivity was 2940 kgs per hectare. Several studies have shown the existence of yield difference between the potential, the best practices and actual yields in different rice growing areas representing various agro-ecologies. The future increase in rice production requires improvement in productivity and productivity efficiency. There are gaps between yields obtained at research station and farmers' fields. Closing these gaps could improve not only the productivity but also the efficiency of rice production[6]. To maintain national food security there is a need to increase rice production to sustain self-sufficiency.

At present the major problem is that though the production level has increased, there still exists gap between what is achieved and what could be achieved in farmers' fields. It is therefore needed that an attempt is made to analyse the magnitude of the gaps in attainable yields and to explore the

possibilities of relaxing existing constraints in order to bridge the attainable yield gaps and to assess the efficiency levels of farmers resource use. Understanding yield potentials and exploitable gaps in paddy production is required to meet future food requirements amidst strong competition for limited resources. With this background the present study has been undertaken with the objective of exploring the yield gap in rice.

MATERIAL AND METHODS

Survey was conducted in Raichur district of Karnataka as it has the highest area under rice cultivation. Raichur is one of the important rice growing districts of the state with 1,78,356 hectares of land under paddy with the annual production of 5,21,949 tonnes which is highest among the districts of North Eastern Karnataka, hence this region was selected as study area.

Multistage sampling technique was used to select the sample area. In the first stage, Raichur district was selected, further two taluks of Manvi and Raichur were selected based on the highest area. Further 3 villages were selected from each taluk. And 15 farmers were interviewed from each village which consisted of five farmers each from small, medium and large farm categories. Required primary data was collected from the sample respondents for the agricultural year 2015-16.

Analytical Tools:

To fulfil the specific objectives of the study, based on the nature and extent of data, Descriptive analysis, International Rice Research Institute method of yield gap analysis was employed.

Computation of yield gaps

Yield gap was estimated using the methodology developed by the International Rice Research Institute, Manila, Philippines. Various yield gaps were estimated using the following formula

Yield gap I = $Y_p - Y_d$

Yield gap II = $Y_d - Y_a$

Total yield gap = Yield gap I + Yield gap II

Index of realised potential yield = $[Y_a / Y_p] *100$

Index of realised potential farm yield = $[Y_a / Y_d] *100$

Index of yield gap = [Yp – Ya / Yp] * 100

Where,

Yp= Potential Yield (Experimental station yield)

Yd= Potential Farm Yield (Front line demonstration yield)

Ya= Actual Yield realized by the sample farmers

RESULTS AND DISCUSSION

Yield gap of paddy in the study area

A comparison of average experiment station yield, potential farm yield and farmers yield of paddy is presented in the Table 1 and Figure 1.

Yield gap in case of paddy indicated that the yield realised at the experimental station was 70 quintals per ha and the potential farm yield was found to be 65 quintals with the yield gap of 7.14 per cent (5 q). This yield gap I possibly existed because of the environmental differences between the experimental stations and the demonstration plots. The overall farm average in Sindhanur taluk was 65.5 quintals per ha accounting to the yield gap II of -0.5 per cent whereas, it was 64 quintals per ha in Manvi taluk of Raichur district. Thus the yield gap II in Manvi taluk was 1.00 quintals per ha. Thus it could be seen that actual yield was 0.5 quintals more than potential farm yield in Sindhanur taluk, whereas it was 1 quintal lesser than the potential farm yield in Manvi taluk. The negative yield gap in Sindhanur can be attributed to the adoption of improved cultivation technologies, farm mechanisation, better irrigation facility. Sindhanur area lies in the mid reach of the Tungabhadra Canal Command, which ensures better irrigation thus aiding better yields. The results of the present study was found to be in contradiction with the study conducted by Nirmala *et al*., The study revealed that the potential yield was 65 quintals per ha whereas the potential farm yield was 56.9 quintals per ha and actual farm yield was 50.17 quintals per ha. Thus the farmers actual yields had increased over the years and the farmers were operating in the potential farm yield level. This advancement

can be attributed to the better management practices taken up by the farmers in the study area with better farming experience and adoption of technologies. Further it can be concluded that there exists a total yield gap of 4.5 quintals and 6.0 quintals per ha in Sindhanur and Manvi taluk respectively.

Yield variation in paddy among different farm groups

Table 2 and Figure 2 reveals the yield variation among different categories of farmers in cultivation of paddy. The overall yield realised by the farmers of all three categories added upto 64.75 quintals per ha which is marginally lower than the potential farm yield revealing the yield gap of 0.25 quintals per ha. Among the different categories of farmers, large farmers have realised highest yield of 66.5 quintals per ha followed by medium (64.75 q/ha) and small farmers (63 q/ha). The yield gap in relation to potential farm yield in case of small, medium and large farmers was found to be 2, 0.25 and -1.5 quintals per ha accounting to the percentage yield gap of 3.07, 0.38, -2.30 per cent among small, medium and large farmers, respectively.

Indices of yield gap in paddy

Index of yield gap refers to the percentage of the yield potential unrealised. Index of potential realisation refers to the percentage of the yield potential achieved. The indices of yield gap under paddy is given through **Table 3 and Figure 3**. In the case of paddy, the IRPY was highest among large farmers (95%) followed by medium (92.5%) and small farmers (90%). This shows that there is untapped potential of 5 per cent in the case of large farmers, 7.5 per cent in the case of medium farmers and 10 per cent in the case of small farmers.

Distribution of the respondents into different yield gap category

Table 4 gives the distribution of paddy farmers into different yield gap category. It could be inferred that 13.33 per cent of the farmers fall in the negative yield gap category. Most of the farmers were found to cover in the yield gap category of zero to 10 per cent, whereas only 3.33 per cent of the farmers were found in the yield gap category of 21 to 30 per cent. It could also be seen that the large farmers were in lesser yield gap category as compared to small and medium farmers. It is important to note that in the cultivation of paddy most of the farmers were found to fall in the yield gap category of zero to 20 per cent indicating better use of resources and management. The lesser yield gap in paddy cultivation can be attributed to the better irrigation facility in the study area and also because of timely operations carried by the paddy farmers.

Constraints perceived by the farmers in production of paddy

It is important to identify the constraints perceived by the farmers in production of crop. Therefore an opinion survey was carried out to elicit the opinions of the farmers on constraints in the production of paddy. The relative importance of the opinions of the farmers regarding the major constraints in realizing the potential were prioritized by using Garrett's ranking technique and are presented in **Table 5**. It revealed that non availability of the adequate labour was found to be the major problem with the Garett score of 82 followed by high incidence of blast, incidence of pest, non timely release of water, non availability of fertilizers and pesticides, and high costs of fertilizers and pesticides. Problem with the irrigation water availability was mainly observed with the farmers of Manvi area since the region lies in the tail end of Thungabhadra Project Command Area. Similar constraints opined by the respondents in paddy cultivation was reported by Nirmala, where timely availability of fertilizers was the major constraint in rice production.

Table 1: Yield gap in paddy production (n=90)

Sl. No	Particulars	Yield (q/ha)	Yield gap (q/ha)	Percentage gap	Remarks
1.	Potential yield	70.00	-	-	-
2.	Potential farm yield	65.00	5.00	7.14	Yield gap I
3.	Farm average yield				
a.	Sindhanur taluk	65.50	-0.50	-0.76	Yield gap II
b.	Manvi taluk	64.00	1.00	1.53	Yield gap II
4.	Total yield gap				
a.	Sindhanur taluk	-	4.50	-	Yield gap I+ Yield gap II
b.	Manvi taluk	-	6.00	-	Yield gap I+ Yield gap II

Table 2: Yield variation in paddy production across farm size (n=90)

Sl. No	Particulars	Average yield (q/ha)	Yield gap (q/ha)*	Percentage gap
1.	Potential farm yield	65.00	-	-
2.	Actual farm yield	64.75	0.25	0.38
3.	Small farmers	63.00	2.00	3.07
4.	Medium farmers	64.75	0.25	0.38
5.	Large farmers	66.50	-1.50	-2.30

Note: Yield gap in relation to potential farm yield

Table 3: Indices of yield gap in paddy production across farm size (per cent)

Farm size	Index of realised potential yield	Index of realised potential farm yield	Index of yield gap
Small	90.00	96.92	10.00
Medium	92.50	99.60	7.50
large	95.00	102.30	5.00
overall	92.50	99.60	7.50

Table 4: Distribution of the sample farmers under different yield gap category in paddy production (n=90)

Yield gap category Percentage	Number of respondents			
	Small farmers	Medium farmers	Large farmers	Total
-20 to -11	-	-	1 (3.33)	1 (1.11)
-10 to -1	2 (6.67)	3 (10.00)	6 (20.00)	11 (12.22)
0 to 10	13 (43.33)	11 (36.67)	14 (46.67)	38 (42.22)
11 to 20	13 (43.33)	15 (50.00)	9 (30.00)	37 (41.11)
21 to 30	2 (6.67)	1 (3.33)	-	3 (3.33)
Total	30 (100.00)	30 (100.00)	30 (100.00)	90 (100.00)

Note : Figures in parenthesis indicate percent to respective total

Table 5: Constraints opined by the respondent farmers in production of paddy

Sl No	Constraints	Garett score	Rank
1	Non availability of adequate labour	82	I
2	High incidence of blast and other diseases	76	II
3	Incidence of pest	71	III
4	Non timely release of water	62	IV
5	Non availability of fertilizers and pesticides	58	V
6	High cost of fertilizers and pesticides	68	VI
7	Lack of technical knowledge about timely application of fertilizers	53	VII
8	High price fluctuation	47	VIII
9	Delayed release of institutional credit	42	IX
10	Lack of storage facilities	40.25	X

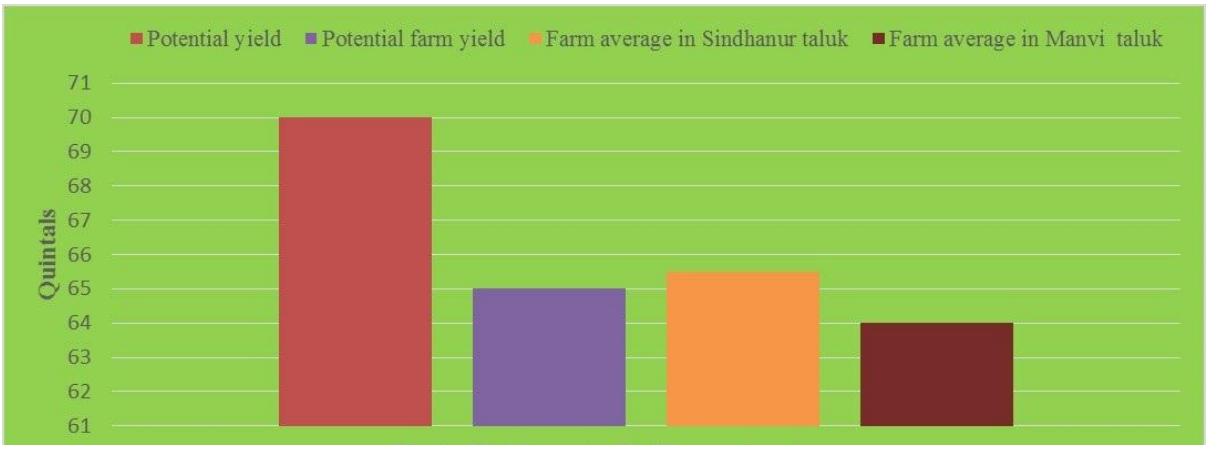

Fig. 1: Yield gap in paddy production

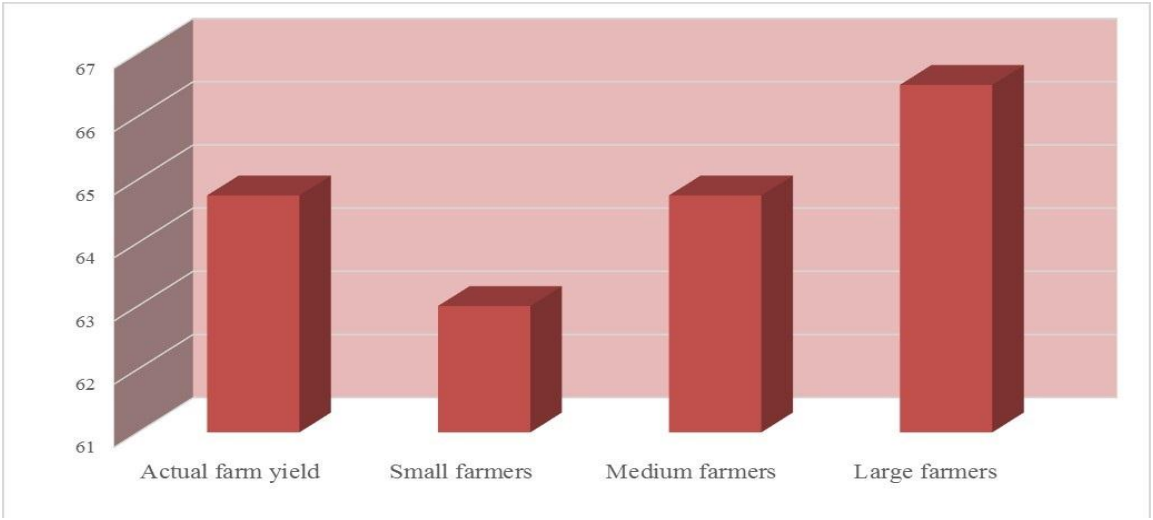

Fig. 2: Yield gap of paddy across farmer categories

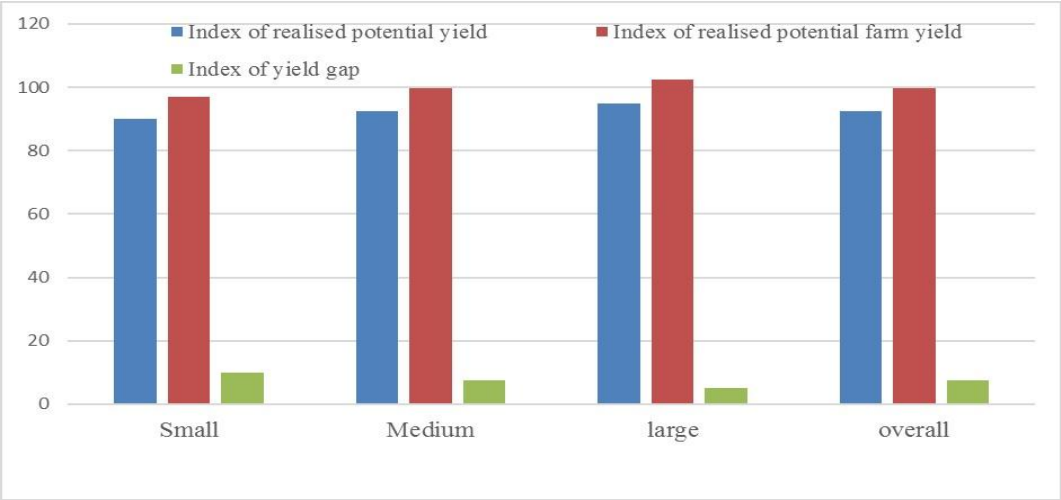

Fig. 3: Indices of yield gap in paddy

CONCLUSION

Productivity change in agriculture is an autonomous process but it can be accelerated by coherent and enabling Government policies as witnessed during the Green Revolution. However, productivity gains in agriculture are unequal in time and space. Growth in agricultural productivity has been virtually absent in many parts of the country. In other parts of the world, further gains in the agricultural productivity are questioned as yields of many crops are already high[7]. A better insight in the yield gap and the underlying factors is a crucial source of information for those that want to define, assess or evaluate measures aimed at stimulating agricultural production and rural development including combating malnutrition and hunger. Though the productivity in food grains has increased recently, yield gaps still exists, which implies that there are possibilities of raising production by increasing yield of most of the crops. Though there does not exist much yield gap in paddy in the study region, same might not be the case of other paddy growing area. Hence the studies on yield gap may concentrate on resource poor regions. The various factors responsible for such gaps may also be explored.

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