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Short communication

Yield gap of rice in Alappuzha district of Kerala

Elsamma Job*

Department of Agricultural Economics, College of Agriculture, Kerala Agricultural University, Vellayani 695 522, Thiruvananthapuram, Kerala.

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Abstract

To evaluate the gap between maximum feasible and actual yields obtained by rice (*Oryza sativa*) farmers of Alappuzha, a study was conducted adopting a three stage random sampling scheme. Frontier production function was used to estimate the maximum feasible yield (MFY) and yield gap. Rice yield gap in Alappuzha was estimated as 1588 kg ha^{-1} with an MFY of 5447 kg and actual yield of 3859 kg ha^{-1} implying the occurrence of certain constraints in raising productivity at the farm-level.

Keywords: Frontier production function, Maximum feasible yield, Stochastic frontier model.

Large gaps between the yield levels of research/ demonstration farms and farmers' plots signify that farmers seldom realize more than 30% of the possible yields (Nirmala, 1992). Nowhere is the problem as acute as the main rice (*Oryza sativa*) growing areas of Kerala. Therefore, a study was undertaken to assess the gap between the maximum feasible yield and the yield realized by the farmers in Alappuzha district, one of the 'rice bowls' of Kerala with 61% high yielding variety coverage. This study also elucidated the major yield constraints of rice in this locality.

Data were collected adopting a three-stage random sampling scheme in which the community development blocks (CD blocks) formed the primary level; *Krishibhavans* (*Panchayaths*) constituted the secondary level and the individual farmers formed the tertiary level. The 12 CD blocks in Alappuzha district were arranged in the ascending order of rice productivity and two blocks representing high and low productivity (Champakulam and Bharanikavu falling under the agroclimatic situations Kuttanad and Onattukara respectively) were selected (i.e., blocks with the largest area falling above and below the productivity median). From the selected blocks, one *krishibhavan* each with the largest area under rice was further selected (Kainakary and Chunakara representing the high productivity and low productivity classes respectively). Out of the progressive farmers of these two locations (one getting consistently higher yield during the years preceding 1999-2000 and adopting all major practices recommended for paddy cultivation – 202 and 101 such farmers in Kuttanad and Onattukara respectively), a sample of 10% was chosen at random with a corresponding number of average farmers. Accordingly, 10 progressive and average farmers each from Kuttanad and Onattukara constituted the sample.

Frontier production function was used to estimate the maximum feasible yield (MFY) and yield gap. MFY was estimated from frontier production function (MFY function) using the maximum likelihood estimate (MLE). In identifying the yield gap, contribution of each factor to yield was determined using the Cobb-Douglas production function, which served as the lower bound for MLE. Yield gap is the difference between MFY and the actual yield obtained by the farmers. The

*Author for correspondence: Phone +91 471 238 1002; Fax +91 471 238 2239; E- mail <elsammajob@gmail.com>.

stochastic frontier model used to estimate the maximum feasible yield (Kalirajan, 1990) was:

$$y_i = a + \Sigma\beta_i x_i + u_i + v_i$$

where y_i= yield kg ha^{-1}, i= 1, 2, 3……. n farms, u_i= farm specific technical efficiency related factor a= intercept, β_i = co-efficient, while x_i and v_i are variables

The function, $a + \Sigma\beta_i x_i$, denotes a farm's frontier yield or MFY when the best practices and techniques are adopted ($u=0$) with no statistical errors in estimates and influence of external factors (climate, topography); errors in measurement and observations on production are also negligible ($v=0$). Variance ratio explaining the total variation in output from the frontier level of production attributed to technical efficiencies can be computed as $\gamma = \sigma^2 u/\sigma^2(u+v)$. γ signifies whether the differences in technical efficiencies were actual or accidental. The smaller the ratio, the higher is the probability of the difference being accidental and a value close to unity suggests the non-use of best production practices.

The model used for this study was:

$$y_i = \beta o+\beta_1 logx_1+\beta_2\, logx_2+\beta_3\, logx_3+u_i+v_i$$

Where i= 1, 2, 3… n farms, y_i= yield (kg ha^{-1}), x_1= man days per ha, x_2= plant protection cost ha^{-1}, x_3= chemical fertilizers ha^{-1}, u_i= farm specific technical efficiency related factor, and v_i= random variable.

Estimates of MFY functions are given in Table 1. The estimated value of γ for average farmers approached unity (0.93) implying that u is the predominant source of error and variations in yield from MFY arise not only from chance factors, but also due to differences in the use of the best practices. This means that if the production technology of each farmer were raised to the best-known practices and techniques, then all farmers would be able to attain the maximum level of production. This also means that a number of farmers do not produce the greatest possible outputs from a given set of inputs and are therefore not technically efficient.

In the case of progressive farmers, γ tends to be zero (0.03) and v is the predominant error suggesting that the farmers' yield differs from MFY because of either statistical errors or those external factors not under their control. When the analysis was done for the combined group, the value of γ was 0.57 indicating that both non-use of the best practices and statistical errors or external factors may be responsible for the yield differences.

A perusal of the data in Table 2 also reveals that mean MFY estimated for the average farmers is 4966 kg ha^{-1} and the realised yield is 3141 kg resulting in a gap of 1825 kg ha^{-1}. On the other hand, the MFY estimated for the progressive farmers was 5927 kg ha^{-1} while the actual yield was 4577 kg implying an yield gap of 1350 kg. The yield gap estimated for the combined group was 1588 kg ha^{-1} with an MFY of 5447 kg and actual yield of 3859 kg ha^{-1}. This is much higher than the yield gap value

Table 1. Estimated parameters of maximum feasible yield functions

Variables	Maximum feasible yield		
	Average	Progressive	Combined
a (constant)	2.535*(0.126)	2.920*(0.128)	2.723*(0.148)
C (season dummy)	0.030(0.013)	0.050*(0.012)	0.038*(0.106)
L (location dummy)	0.063**(0.029)	0.238*(0.024)	0.216*(0.014)
x_1 (labour days)	0.089(0.061)	0.428*(0.076)	0.264*(0.053)
x_2 (lime cost)	0.015*(0.004)	0.183**(0.082)	0.020*(0.005)
x_3 (organic manure cost)	0.012 (0.009)	0.003(0.014)	0.206**(0.006)
x_4 (fertilizer cost)	0.210**(0.054)	0.032(0.044)	0.075***(0.042)
γ	0.93	0.033	0.57
σ^2	1.08	3.36	1.76

Figures in parentheses are standard errors; *Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level.

Table 2. Mean realised yield, maximum feasible yield, and yield gap in Alappuzha District of Kerala.

Categories of farmers	Realized yield (kg ha^{-1})	Maximum feasible yield (kg ha^{-1})	Yield gap (kg ha^{-1})
Average	3150	4974	1824
Progressive	4569	5919	1350

reported for rice by Kalirajan (1990) and Nirmala (1992). Implicit in this is that major constraints operate against raising the productivity of rice in the study locations. Among the constraints identified in Kuttanad region, floods, untimely sowing, absence of suitable varieties, lack of good quality seeds, scarcity of labour, and high cost of inputs are prominent. However, soil problems, drought, lack of irrigation, scarcity of labour, and high costs of inputs are the major constraints experienced by the Onattukara farmers. Since average yield at the aggregate level was only 3859 kg ha^{-1}, there is ample scope for increasing rice production by bridging the yield gap through addressing the production constraints. Indeed, bridging the yield gap of 1588 kg ha^{-1} alone can increase the production substantially and the farmers can get a mean yield of 5447 kg ha^{-1}.

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