Factors Affecting Alternate Rice-Fish Production of Mymensingh District in Bangladesh

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Abstract: Cobb-Douglas production function has been used to measure the effect of various factors on alternate rice-fish production. The chosen factors were of fingerlings cost, cost of cow dung, cost of rice bran, cost of oil cake, cost of lime, cost of urea cost of human labour and cost of netting for fish production and for rice production the factors were human labour, animal labour. Cow dung, urea, TSP, MP, seed and irrigation cost. It was found that except cost of rice bran and lime for fish production all the factors were statistically significant and for the rice production animal labour, TSP and irrigation cost were the insignificant.

Keywords: Returns to scale, significant, explanatory variable

INTRODUCTION

Bangladesh is an agro based developing country. The future development of the country is very much related with agricultural sectors. As a sub sector of agriculture, fisheries second in rank. Fisheries play a significant role in nutrition, employment and foreign exchange earning. Agriculture contributes 32.4% to the GDP and of this 3.20% comes from fisheries sub sector[1]. The contribution of this sub sector to the national foreign exchange earning is about 9%[2]. Fishery industry in Bangladesh provides livelihood to 11.2 million full time fishermen and to 10 million part time fishermen.

Possibilities to expand marine fishery are very limited, due to marine fishery operation are very capital intensive and require skilled labour both of which are scarce in Bangladesh. Also people of our country are less habituated to take marine fish in their diet. Therefore, inland water is the preferred source for increasing fish production there by minimizing the protein deficiency[3].

It is often argued that the future development of our country depends particularly on the agriculture sector. Fish also uses space more efficiency than many other domestic animals. A comparative study conducted in Hungary and Taiwan indicated that the production of fish cultivation fish was much lower than that of beef and poultry[4].

In this study important inputs and other related factors that affect the output of alternate rice-fish production have been assessed. The analysis is based on data for the year 2000-2001 of a sample of 80 alternate rice-fish farmers from different areas of Bhaluka thana of Mymensingh district.

MATERIALS AND METHODS

Cobb- Douglas form of production function was chosen on the basis of best fit and significant result of output. Eight inputs namely fingerlings, rice-brown, oil cake, salt, urea, lime, cow dung and human labour were used which were considered as A priori explanatory variables responsible for variation in fish Production. And for rice production also eight inputs namely human labour, animal labour, cow dung, urea, TSP, MP, seed and irrigation employed which are considered as A priori explanatory variables.

The models of the following forms for the analysis were used:

\[ Y = \alpha x_{1}^{a} x_{2}^{b} x_{3}^{c} x_{4}^{d} x_{5}^{e} x_{6}^{f} x_{7}^{g} x_{8}^{h} u \]

or \[ \ln Y = \ln \alpha + b_{1} \ln x_{1} + b_{2} \ln x_{2} + b_{3} \ln x_{3} + b_{4} \ln x_{4} + b_{5} \ln x_{5} + b_{6} \ln x_{6} + b_{7} \ln x_{7} + b_{8} \ln x_{8} + u \]

For fish production

\[ Y = \text{Gross income (Tk ha}^{-1}) ,\]

\[ x_{1} = \text{Cost of Fingerlings (Tk ha}^{-1}) ,\]

\[ x_{2} = \text{Cost of cow dung (Tk ha}^{-1}) ,\]

\[ x_{3} = \text{Cost of rice bran (Tk ha}^{-1}) ,\]

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\[
\begin{align*}
  x_1 &= \text{Cost of oil cake (Tk ha}^{-1}\text{)}, \\
  x_2 &= \text{Cost of lime (Tk ha}^{-1}\text{)}, \\
  x_3 &= \text{Cost of urea (Tk ha}^{-1}\text{)}, \\
  x_4 &= \text{Cost of human labour (Tk ha}^{-1}\text{)}, \\
  x_5 &= \text{Cost of netting (Tk ha}^{-1}\text{)}, \\
  a &= \text{Constant or intercept,} \\
  b_i - b_0 &= \text{Co-efficient of the relevant variables and} \\
  \iota_i &= \text{Disturbance term. And for rice production} \\
\end{align*}
\]

Where,

\[
\begin{align*}
  Y &= \text{Gross income (Tk ha}^{-1}\text{)}, \\
  x_1 &= \text{Cost of Human labour (Tk ha}^{-1}\text{)}, \\
  x_2 &= \text{Cost of Animal labour (Tk ha}^{-1}\text{)}, \\
  x_3 &= \text{Cost of Cowdung (Tk ha}^{-1}\text{)}, \\
  x_4 &= \text{Cost of urea (Tk ha}^{-1}\text{)}, \\
  x_5 &= \text{Cost of TSP (Tk ha}^{-1}\text{)}, \\
  x_6 &= \text{Cost of MP (Tk ha}^{-1}\text{)}, \\
  x_7 &= \text{Cost of seed (Tk ha}^{-1}\text{)}, \\
  x_8 &= \text{Cost of irrigation (Tk ha}^{-1}\text{)}, \\
  a &= \text{Constant or intercept,} \\
  b_i - b_0 &= \text{Co-efficient of the relevant variables and} \\
  \iota_i &= \text{Disturbance term.}
\end{align*}
\]

**RESULTS AND DISCUSSION**

The results indicate that Cobb-Douglas production function fitted well as considering \(R^2\) and \(F\) value. The coefficient of multiple determination for fish production \(R^2\) was 0.95 and adjusted \(R^2\) was 0.92 which means that explanatory variables included in the model explained 95% of the variation of fish production. The \(F\)-value of fish production was 25.367 which is highly significant at 1% level. The return to scale of all production co-efficient of sample farmers for fish production was 0.77 which indicates that the production exhibit decreasing return to scale. In other words, if all the inputs specified in the function were increased by 1%, output would have increase by 0.77%. It is evident from Table 1 that the 8 variable of fish production were taken for interpretation of results. The level of significance used 1, 5 and 10%. Of all these variable costs of Urea, MP and seed were significant at 1% level. Cost of human labour was significant at 5% of level, cost of cowdung was significant at 10% level and costs of animal power, TSP and irrigation were insignificant. The estimated production co-efficient for human labour, cowdung, Urea, MP and seed were significant and had positive effect upon gross return which implies that for every 1% increase in the significant variable gross return will be increased, assuming that other inputs were held constant. On the other hand, the estimated production co-efficient for animal power, TSP and irrigation were insignificant which indicates that there was a chance to decrease the gross return per hectare by spending additional amount for cost of rice bran and lime. An increase of 1% in the cost of rice bran and lime keeping other factors constant, would result in a decrease of gross return.

The results indicate that Cobb-Douglas production function fitted well as indicated by \(R^2\) and \(R^2\). The coefficient of multiple determinations \(R^2\) is 0.874 for rice production which means that the explanatory variables included in the model explained 87.4% of the variation of rice production. The \(F\)-value of rice production was 4.339 which was highly significant at 1% level. The return to scale of all production co-efficient of sample farmers for rice was 1.22. This indicates that the production exhibits increasing return to scale. In other words, if all the inputs specified in the function were increased by 1 percent output would have increased by 1.22%.

It is evident from the Table 1 that 8 variables of rice production were taken for interpretation of results. The level of significance used 1, 5 and 10%. Of all these, variable costs of Urea, MP and seed were significant at 1% level. Cost of human labour was significant at 5% of level, cost of cowdung was significant at 10% level and costs of animal power, TSP and irrigation were insignificant. The estimated production co-efficient for human labour, cowdung, Urea, MP and seed were significant and had positive effect upon gross return which implies that for every 1% increase in the significant variable gross return will be increased, assuming that other inputs were held constant. On the other hand, the estimated production co-efficient for animal power, TSP and irrigation were insignificant which indicates that there was a chance to decrease the gross return per hectare by spending additional amount for cost of animal power, TSP and irrigation. An increase of 1% in the cost of animal power, TSP and irrigation keeping other factors constant would result in a decrease of gross return.

In addition to regression analysis, tabular method is also used here to show cost, yield and profitability of alternate rice-fish culture (Table 2). For the purpose of this study, size of farm is specified as follows: Small farmers holding land between 0.02 to 1.01 ha (0.05 to 2.49 acres), medium farmers 1.02 to 3.03 ha (2.5 to 7.49 acres) and those of large farmers owned land between 3.03 ha and above (above 7.5 acres). Most of the alternate rice-fish farms are in medium size category and represent 55 percent of total farms. The numbers of small and large farms are 30 and 15%, respectively.

Alternate rice-fish culture comprises two components namely fish and rice. The average per hectare yield of fish was 1105.93 kg. Per hectare returns from fish was Tk 47764.48. For rice components average per hectare yield was 4444 Kg. Moreover, the alternate rice-fish farmers
Table 1: Estimated values of co-efficient and related statistics of fish and rice production

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>Co-efficient</th>
<th>Rice production</th>
<th>Explanatory variables</th>
<th>Co-efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>3.747 (.543)</td>
<td>Intercept</td>
<td>2.133 (2.047)</td>
<td></td>
</tr>
<tr>
<td>Fingerlings (x1)</td>
<td>0.082** (.034)</td>
<td>Human labour (x1)</td>
<td>0.719** (.223)</td>
<td></td>
</tr>
<tr>
<td>Cowdung (x2)</td>
<td>0.008*** (.034)</td>
<td>Animal labour (x2)</td>
<td>-0.359 (.116)</td>
<td></td>
</tr>
<tr>
<td>Rice bran (x3)</td>
<td>-0.664 (.021)</td>
<td>Cowdung (x3)</td>
<td>0.866*** (.060)</td>
<td></td>
</tr>
<tr>
<td>Oil cake (x4)</td>
<td>0.024** (.016)</td>
<td>Urea (x6)</td>
<td>0.258* (.071)</td>
<td></td>
</tr>
<tr>
<td>Lime (x5)</td>
<td>-0.113 (.035)</td>
<td>TSP (x11)</td>
<td>-0.365 (.096)</td>
<td></td>
</tr>
<tr>
<td>Urea (x6)</td>
<td>0.144* (.049)</td>
<td>MP (x12)</td>
<td>0.340* (.840)</td>
<td></td>
</tr>
<tr>
<td>Human labour (x7)</td>
<td>0.051** (.025)</td>
<td>Seed (x13)</td>
<td>0.789* (.156)</td>
<td></td>
</tr>
<tr>
<td>Netting (x8)</td>
<td>0.517* (.087)</td>
<td>Irrigation (x14)</td>
<td>-0.264 (.095)</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.95</td>
<td>R²</td>
<td>0.874</td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.92</td>
<td>Adjusted R²</td>
<td>0.673</td>
<td></td>
</tr>
<tr>
<td>Return to scale (Tk/h)</td>
<td>0.77</td>
<td>Returns to scale (Tk/h)</td>
<td>1.22</td>
<td></td>
</tr>
<tr>
<td>F-value</td>
<td>25.367</td>
<td>F-value</td>
<td>4.339</td>
<td></td>
</tr>
</tbody>
</table>

Note: * Significant at 1% level. ** Significant at 5% level. *** Significant at 10% level. Figures within the parentheses indicate standard error.

Table 2: Cost and economic return of fish and rice under alternate rice-fish culture

<table>
<thead>
<tr>
<th>Farm sizes</th>
<th>Small farms</th>
<th>Medium farms</th>
<th>Large farms</th>
<th>All farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Items</td>
<td>Quaty. (unit)</td>
<td>Return (Tk)</td>
<td>Quaty. (unit)</td>
<td>Return (Tk)</td>
</tr>
<tr>
<td>Returns</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish (kg)</td>
<td>1123.85</td>
<td>46830.83</td>
<td>1076.2</td>
<td>46016.79</td>
</tr>
<tr>
<td>Rice (Kg)</td>
<td>4323</td>
<td>25848.08</td>
<td>4491</td>
<td>27813.66</td>
</tr>
<tr>
<td>By-product (straw)</td>
<td>-</td>
<td>1440.83</td>
<td>-</td>
<td>1475.14</td>
</tr>
<tr>
<td>Gross return</td>
<td>74119.74</td>
<td>75305.59</td>
<td>-</td>
<td>85287.35</td>
</tr>
<tr>
<td>Costs (Tk)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish production</td>
<td>-</td>
<td>3343.99</td>
<td>-</td>
<td>32025.326</td>
</tr>
<tr>
<td>Rice production</td>
<td>13216.91</td>
<td>13503.93</td>
<td>14203.61</td>
<td>14388.78</td>
</tr>
<tr>
<td>Gross cost (Tk)</td>
<td>46656.24</td>
<td>47079.26</td>
<td>54268.74</td>
<td>-</td>
</tr>
<tr>
<td>Net benefit (Tk)</td>
<td>27463.5</td>
<td>28226.33</td>
<td>31018.61</td>
<td>28415.90</td>
</tr>
</tbody>
</table>

The result of this study indicates that both the fish and rice production can be increased by using of modern and scientific production technology. In the study areas, the survey data have shown that the average yield of fish is only 1106 kg ha⁻¹ and per hectare rice production is 4444 kg. It can be easily increased more than 3 times by using proper doses of fertilizer and modern production technology. Therefore, there is enough possibilities to increase yield per hectare through intensive methods of cultivations. On the other hand, all cultivable of alternate rice-fish farms should be brought under scientific method to extend the farming area and to increase productions.

REFERENCES