Economic Evaluation of Transplanted Rice as Influence by different Trellis Vegetables


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Abstract — The aim of this study is to find out effects of different trellis-vegetables grown at the edge of the rice field on the productivity and profitability of transplanted modern aman rice BINA Dhan-7. The study design was held as a Randomized Complete Block Design (RCBD) since it was repeated three times. The experimental treatments were T1 = rice + bottle gourd, T2 = rice + white gourd, T3 = rice + yard long bean, T4 = rice + bitter gourd and T5 = rice + cucumber. The results revealed that grain yield was the highest (3.48 t ha−1) in rice + cucumber (T5) and the lowest grain yield (2.65 t ha−1) was found in rice + bottle gourd (T1). In terms of vegetable production, the maximum vegetable yield (21.33 t ha−1) was obtained from rice + bottle gourd (T1) and the minimum value (0.25 t ha−1) was received from rice + cucumber (T3) crop combination. Moreover, the highest rice equivalent yield (23.98 t ha−1) was found from rice + bottle gourd (T1) crop combination and lowest value (3.48 t ha−1) was found from rice + cucumber (T5) crop combination. The highest value of gross return (Tk. 316290 ha−1) was obtained from the T1 treatment (rice + bottle gourd) and the lowest value of gross return (Tk. 50835 ha−1) was recorded from the treatment T5. The maximum benefit-cost ratio (3.35) was recorded from T1 treatment and the lowest benefit-cost ratio (0.71) was observed in T5 treatment. Finally, the growing of bottle gourd production at the edge of transplanted aman rice BINA Dhan-7 cultivation approach will be a significantly beneficial production technique.

Keywords — Transplanted Rice, Trellis Vegetables, Equivalent Yield, and Benefit-Cost Ratio.

I. INTRODUCTION

Bangladesh's geographical and agro-climatic conditions are favourable for rice cultivation, as it is the staple food crop covering 74.28% of the total land area [1]. Rice accounts for 95% of annual food grain production and provides 75% of the calories and 55% of the protein in the average daily diet in Bangladeshi people [2]. The agricultural land of Bangladesh is being reduced by approximately 1.0% of the total area per annum [3], while the population is increasing by 1.36% [4], and hence, the demand for food grain is ever increasing. That being the reason, the food crisis is seen every year. Achieving self-sufficiency in rice production and sustaining this to face the ever-growing population pressure continues to be the major goal of agricultural planning, research, and extension in the country.

There is adequate demand in the market in vegetable production, but the supply is limited due to the land shortage of vegetables. Vegetable crops, excluding potato, occupy only 1.8% of the total cropped area with gross production of only 1.63 metric tons [5]. The per capita consumption of vegetables in Bangladesh is 53g, far behind the daily human requirement of 200g/head/day. The vegetable requirement is 10.22 metric tons/year against the current production of 2.71mtons/year [6]. This scenario creates an artificial crisis in the market. Therefore, the availability of vegetable in Bangladesh is exceedingly low when compared with other countries. Cereal consumption is the highest here, and vegetable consumption is the lowest [7]. The people of developed countries consume a great part of their food in the form of vegetable. In most of the developed countries, more than 40% of the plant-based food comes from vegetable. In Japan and the UK, almost half of the plant-based food comes from vegetable [8]. In many developed countries, cereals and vegetables, including roots and tubers, are produced in the ratio of 1:2 (by weight). The ratio in many of the developing countries of Asia is some 2:1, but in Bangladesh, it is 5:1 [9].
Moreover, the vegetable crops may be cultivated on the raised ails along one side of the rice plot. There would be a little competition between rice and vegetables for several aspects of growth and developmental parameters. Therefore, if adequate quantities of the vegetable can be grown on trellis without having any effect or causing a little effect on growing rice crops underneath, it would be a useful technology for the poor people of the country to fulfil their nutritional needs of vegetable and at the same time, to make the rice production a system-based, cost-effective and hence, more profitable [10]. To increase and stabilize agricultural production, the means that have greatly received the attention of scientists in recent years are multiple cropping or intercropping. More than one crop is grown simultaneously or in sequence on the same piece of land [11]. The intercropping may provide insurance against adverse environmental conditions. Substantial yield advantages from intercropping compared to monocultures of different crops could complement each other and make better use of growth resources when grown together rather than separately. Very recently, vegetable production in the rice fields, a new concept of multiple cropping, has been under proposition in conditions of Bangladesh, which might produce high potentiality in terms of total production and economic return [12].

Thus, for achieving the maximum benefits from a pitch of land, horizontal expansion of land is not possible than vertical crop production has become for the future security of food. Considering the above-mentioned facts, the field research work purpose is to assess and evaluate the economic benefits of the bottle gourd, white gourd, yard long bean, bitter gourd and cucumber grown at the edge of transplanted aman rice field.

II. MATERIALS AND METHODS

Location

At an altitude of 37.5 meters above mean sea level, the experimental area was situated at 25.56° N latitude and 88.41°E longitude. The field is part of the Agro-ecological Zone 1 (Old Himalayan Piedmont Plain) [13].

Soil and Climate

The experimental area is a medium high land with a pH of 5.35 sandy loam soil. The soil contained 0.10 percent total nitrogen, 1.06 percent organic matter, 24.00 µg/g usable phosphorus, 0.26 me/100g available potassium, 3.2 µg/g available sulphur, and 0.27 µg/g boron, according to the original soil (0-15 cm depth) survey. The soil’s properties were examined at the Soil Resource Development Institute (SRDI) in Dinajpur. The temperature in the research region is sub-tropical. Usually, rainfall is high during the Kharif season (March-September) and sparse during the Rabi season (October-February) (October-February). In the summer (April to September), the average maximum temperature was 28.98°C, while the average minimum temperature was 14.9°C. From July to November, the average humidity was 89.83 percent. The average annual rainfall was 175 mm, with the majority of it falling in brief bursts throughout September. Wheat Research Centre (WRC), Nashipur, Dinajpur, provided the weather details.

Experimental Design

With three replications, the experiment was set up in a Randomized Complete Block Design (RCBD). The treatments were as follows-

\[ T_1 = \text{rice + bottle gourd} \]
\[ T_2 = \text{rice + white gourd} \]
\[ T_3 = \text{rice + yard long bean} \]
\[ T_4 = \text{rice + bitter gourd} \]
\[ T_5 = \text{rice + cucumber} \]

Crop Establishment for Rice

A basic gravity approach was used to pick healthy seeds. The seeds were then immersed in water for 24 hours in a bucket. The soaked seeds were taken out of the water and placed in a dark gunny sack. On July 1, 2011, BINA Dhan-7 was sown in a well-prepared seedbed after sprouting seeds. Seedlings were carefully raised in the seedbed. Irrigation and weed removal from the seedbed is undertaken on a regular basis. On July 25, 2011, the field was ploughed extensively with a tractor-driven disk plough and then harrowed. After that, the field was
ploughed four times with a country plough, supplemented by two laddering to level the surface. The field was cleared of weeds and stubble. As a result, the land was planned for rice seedling transplantation. Specific plots were then flattened and puddled with spades in preparation for transplanting rice seedlings. Urea, TSP, MP, gypsum, and zinc sulphate were added at rates of 130, 50, 85, 60, and 20 kg ha⁻¹, respectively, according to the BRRI guideline. The whole TSP, MP, gypsum, and zinc sulphate was applied as a basal dose in the unit plots during final land preparation and thoroughly combined with soil using a spade. Urea was applied to the top of the rice at 15, 30, and 45 days after transplanting (DAT). In the days prior to uprooting the seedlings, water was applied to the seedbed both in the morning and in the evening. Seedlings were gently uprooted without risking damage to the roots and kept in the shade. On July 30, 2011, only the selected stable seedlings were transplanted into the experimental plots in 25 cm apart rows with a 15 cm spacing between hills and 2-3 seedlings hill⁻¹. Some hill seedlings died and were substituted on August 10 with seedlings from the same source. The experimental area was irrigated to retain a steady volume of standing water up to 6 cm at the beginning to encourage early tillering and 10-12 cm at the end to prevent late tillering. Irrigation was applied to the experimental plots when required. To improve crop maturity, water was eventually drained from the field at the hard dough level. The rice crops were infested with a variety of weeds. Weeds were uprooted by hand at 15 to 45 DAT to hold the plots weed-free. During the growing cycle, the crop was found to be infested with stem borer, rice hispa, rice moth, and plant hoppers. Insect pests were successfully monitored by broadcasting Furadan 5G @10kg ha⁻¹ on September 5 during the active tillering stage. Diseases such as blast and brown spots were found to be insignificant, and no control measures were needed.

Crop maturity was measured when 80 percent of the grains turned golden yellow. Five hills (excluding boundary hills) were chosen randomly from each unit plot and uprooted before harvesting to report data other than yields. Following sampling, the whole plot was harvested at maturity on October 14 by cutting the plants at ground level with a sickle. Each plot's harvested plants were packaged individually, appropriately labelled, and transported to the threshing floor. The crop was threshed with a pedal thresher, and the fresh weights of grain and straw were registered plot-wise. The grain and straw weights were calculated using a moisture content of 14%. Finally, the grain production and strawweight are translated to tonnes per hectare (t ha⁻¹).

**Crop Establishment for Vegetables**

In the trial, the margins of the rice field were used for vegetable planting. The edges were specifically prepared for this. The edges were lifted from north to south. The nails were all 50 cm broad, 3m long, and 25 cm tall. The edges were elevated to that height to avoid root harm to vegetable seedlings induced by water stagnancy in the Aman rice region. The surface soil was extensively spaded and turned into loose, friable clods to ensure a strong tilth. All the bushes, stubble and dead roots were eliminated. The margins were therefore flattened by hand and so well suited for vegetable planting. Vegetable seedlings were raised in polybags. The medium was created by combining cow dung, manure, and dirt. In the prepared polybag, healthy seeds of yardlong bean, bitter gourd, bottle gourd, white gourd, and cucumber were sown. The soil-filled polybags were stored in a sunny and dry place. In order to grow healthy seedlings, proper water conservation methods were implemented. On August 14 2011, thirty-day-old seedlings of Bitter gourd, Bottle gourd, White gourd, and 15-day-old seedlings of yard long bean were transplanted, with a spacing of 50 cm between pits. Any seedlings on the hills died as a consequence of transplanting shock. These seedlings were supplemented by using reserve seedlings of the same age to cover the void. Many of the vegetables chosen had a proclivity for climbing. Trellises were designed for scaling vegetables as a result. Trellises are made out of bamboo and plastic wire. Staking was given to assist ascending vegetable plants in reaching the trellis. Trellising was accomplished by using bamboo sticks. Ripcord 10EC @ 10ml 100 L⁻¹ of water was used for the protection of insect infestation. Bitter gourds were picked first, at 50-60 days after planting, and then every 6 to 7 days after that. In the case of yard long bean, the first harvest was achieved at 50 DAT, and it was harvested many times at 5-day intervals after that. Bottle gourd and white gourd were collected first, at 70 to 80 DAT, and then every 10 to 12 days after that.

**Data Collection for BINA Dhan-7**

Each plot’s five rice hills were chosen at random, the plant height (cm) number of total tillers hill⁻¹, number of effective tillers hill⁻¹, number of non-effective tillers hill⁻¹, length of panicle (cm), number of total spikelets panicle⁻¹, number of sterile spikelets panicle⁻¹, number of grains panicle⁻¹, 1000-grains weight (g), grain yield (t ha⁻¹), straw yield (t ha⁻¹), biological yield (t ha⁻¹) and harvest index data were collected.
Data Collection for Vegetables

After harvesting, the vegetable yields were calculated and converted to t ha\(^{-1}\). Here, yields assessment was made not based on the area on which vegetables were grown but based on the whole plot. The quantity of Aman rice purchased by selling vegetables obtained from the experimental plots under the existing market price was considered the (REY) rice equivalent yield. The formula, proposed by [14] was used to calculate rice equivalent yield.

Economic Analysis

The total labor needed for various activities and the cost of various variable inputs were reported to calculate the total variable cost of production of the crop provided by treatments. Based on the market price of the rice grain, rice straw, and vegetables at harvest, the total cost of output, gross return, net return, and the benefit-cost ratio is determined.

Statistical Analysis

The data from the experiments were evaluated using the methodology designed by the computerized MSTATC software for and parameter. Duncan's Multiple Range Test was used to change the mean variations between treatments (Gomez and Gomez, 1984).

III. RESULTS AND DISCUSSION

Yield and Yield Attributes of Transplanted Aman Rice

Plant Height

In rice cum vegetable cultivation, crop combination was found significant influence on the plant height of transplanted aman rice which has been presented in Table I. The highest plant height (98.19 cm) was found from the treatment combination rice + cucumber (T\(_5\)), and the lowest plant height (94.33 cm) was found from the treatment rice + bottle gourd (T\(_1\)). The result also supported by the findings of Mondal [16].

Number of Fertile Tillers per Hill

There was found significant influenced on the number of fertile tillers hill\(^{-1}\) of transplanted aman rice (Table I). The results showed that highest number of fertile tillers hill\(^{-1}\) (23.09) was found from the treatment combination rice + cucumber (T\(_3\)) which was similar to T\(_4\) and the lowest number of fertile tillers hill\(^{-1}\) (20.67) was found from the treatment rice + bottle gourd (T\(_1\)) that was identical to T\(_2\) crop combination. The result was in agreement with the result of Islam [17].

Number of Unfertile Tillers per Hill

In rice cum vegetable cultivation, crop combination exerted significant influence on the number of unfertile tillers hill\(^{-1}\) of transplanted aman rice. The results showed that numerically the highest number of unfertile tillers hill\(^{-1}\) (2.42) was found from the treatment rice + yard long bean treatment combination (T\(_3\)) and the lowest number of unfertile tillers hill\(^{-1}\) (2.03) was found from the treatment combination of rice + cucumber (T\(_5\)).

Number of Total Tillers per Hill

In rice cum vegetable cultivation, crop combination was found significant influence. The results showed the highest number of total tillers hill\(^{-1}\) (24.31) was found in the treatment combination of rice + cucumber (T\(_i\)) and the lowest number of total tillers hill\(^{-1}\) (22.56) was found in the treatment combination of rice + bottle gourd (T\(_1\)).

Panicle Length

Panicle length did not show any significant influence by crop combination (Table I). The highest panicle length (23.67 cm) was obtained from the treatment combination of rice + cucumber (T\(_3\)) and the lowest panicle length (22.96 cm) was found in rice + white gourd (T\(_2\)) crop combination.

Number of Total Spikelets per Panicle

Number of total spikelets panicle\(^{-1}\) was significantly influenced by crop combination at 1% level of significance. The results showed that the highest number of total spikelets panicle\(^{-1}\) (152.0) was found in the treatment combination of rice + cucumber (T\(_3\)) which was statistically similar to T\(_4\) treatment and the lowest number of total spikelets panicle\(^{-1}\) (140.3) was found in the treatment rice + bottle gourd (T\(_1\)).
Number of Grains per Panicle

Number of grains panicle\(^1\) was significantly influenced by crop combination at 1\% level of significance (Table I). The results showed that the highest number of grains panicle\(^1\) (135.4) was found in the treatment combination of rice + cucumber (T\(_3\)) which was similar to T\(_1\) treatment and the lowest number of grains panicle\(^1\) (126.1) was found in the treatment T\(_1\) (rice + bottle gourd).

Number of Unfilled Grains per Panicle

There was no significant influence of crop combination on number of unfilled grains panicle\(^1\) (Table I). The results showed that the highest number of unfilled grains panicle\(^1\) (15.67) was found in the treatment rice + bottle gourd (T\(_1\)) and the lowest number of unfilled grains panicle\(^1\) (14.52) was found in the treatment combination of rice + cucumber (T\(_3\)).

Weight of 1000 Grains

The crop combination under this study did not found any significant effect on 1000-grain weight of transplanted \textit{aman} rice cv. BINA Dhan-7 (Table I). The highest weight of 1000-grains (19.53 g) was found in the treatment combination of rice + cucumber (T\(_3\)) and the lowest weight (18.72 g) of 1000-grains was observed in the treatment rice + bitter gourd (T\(_4\)).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Fertile tillers hill(^1)</th>
<th>Unfertile tillers hill(^1)</th>
<th>Total tillers hill(^4)</th>
<th>Panicle length (cm)</th>
<th>Total spikelets panicle(^3)</th>
<th>Grains panicle(^1) (no)</th>
<th>Unfilled grain panicle(^1)</th>
<th>1000 grain weight (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T(_1)</td>
<td>94.33 b</td>
<td>20.67 c</td>
<td>2.03 c</td>
<td>22.56</td>
<td>23.20</td>
<td>140.3 c</td>
<td>126.1 c</td>
<td>15.67</td>
<td>18.96</td>
</tr>
<tr>
<td>T(_2)</td>
<td>96.36 ab</td>
<td>20.91 c</td>
<td>2.13 b</td>
<td>22.84</td>
<td>22.96</td>
<td>146.1 b</td>
<td>127.0 bc</td>
<td>16.83</td>
<td>18.77</td>
</tr>
<tr>
<td>T(_3)</td>
<td>96.38 ab</td>
<td>21.87 b</td>
<td>2.42 a</td>
<td>24.13</td>
<td>23.89</td>
<td>146.0 b</td>
<td>127.4 bc</td>
<td>14.83</td>
<td>18.87</td>
</tr>
<tr>
<td>T(_4)</td>
<td>94.86 b</td>
<td>22.38 ab</td>
<td>2.20 ab</td>
<td>23.63</td>
<td>23.60</td>
<td>149.7 ab</td>
<td>132.9 ab</td>
<td>15.24</td>
<td>18.72</td>
</tr>
<tr>
<td>T(_5)</td>
<td>98.19a</td>
<td>23.09 a</td>
<td>2.06 c</td>
<td>24.31</td>
<td>23.67</td>
<td>152.0 a</td>
<td>135.4 a</td>
<td>14.52</td>
<td>19.53</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level of significance</th>
<th>*</th>
<th>*</th>
<th>**</th>
<th>ns</th>
<th>ns</th>
<th>*</th>
<th>ns</th>
<th>ns</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV%</td>
<td>2.61</td>
<td>7.37</td>
<td>5.35</td>
<td>7.46</td>
<td>4.27</td>
<td>4.05</td>
<td>5.08</td>
<td>14.52</td>
</tr>
</tbody>
</table>

Columns having the similar letters means that treatments do not differ significantly, and dissimilar letters mean that treatments differ significantly by Duncan's Multiple Range Test (DMRT) at P ≤ 5\%.

* = 5\% level of significance
** = 1\% level of significance
ns = not significant
CV = Coefficient of variance

Note:
T\(_1\) = rice + bottle gourd
T\(_2\) = rice + white gourd
T\(_3\) = rice + yard long bean
T\(_4\) = rice + bitter gourd
T\(_5\) = rice + cucumber

Grain Yield

Grain yield of transplanted \textit{aman} rice cv. BINA Dhan-7 was significantly influenced by the crop combination (Fig. 1). The results showed that the highest grain yield (3.48 t ha\(^{-1}\)) was found in the treatment combination of rice + cucumber (T\(_3\)) which was identical to T\(_1\) and C\(_4\) treatments and the lowest grain yield (2.65 t ha\(^{-1}\)) was found in the treatment rice + bottle gourd (T\(_1\)). The highest grain yield was found due to higher number of fertile tillers hill\(^{-1}\), number of grains panicle\(^1\) and 1000-grains weight. These results are similar to the findings of Shopan [18].

Straw Yield

The trends in straw yield of transplanted \textit{aman} rice cv. BINA Dhan-7 were similar to grain yield of rice (Fig. 2). The results showed that the highest straw yield (5.23 t ha\(^{-1}\)) was found in the treatment combination of rice + cucumber (T\(_3\)) and the lowest straw yield (4.13 t ha\(^{-1}\)) was found in the treatment rice + bottle gourd (T\(_1\)).
reason might be due to the production of maximum number of total tillers per hill and maximum plant height. The result was in agreement with the result of Hasan [19].

**Biological Yield**

Biological yield of transplanted *aman* rice also showed a similar trend as observed in case of grain and straw yields. Biological yield of transplanted *aman* rice was significantly influenced by crop combination at 1% level of significance (Fig. 3). The results showed that the highest biological yield (8.71 t ha⁻¹) was found in the treatment combination of rice + cucumber (T₅) and the lowest biological yield (6.78 t ha⁻¹) was found in the treatment rice + bottle gourd (T₁). Higher biological yield might be due to its higher grain and straw yields. This result also confirms to the findings of Amin [20].

**Harvest Index (%)**

The crop combination under this study was found significant effect on harvest index of transplanted *aman* rice cv. BINA Dhan-7 at 1% level of significance (Fig. 4). The highest value of harvest index (40.46%) was found in the treatment rice + yard long bean (T₃) which was similar to T₄ treatment. The lowest value of harvest index (38.49 %) was found in the treatment rice + bottle gourd (T₁).
Vegetable Yield

Crop combination had significantly influenced the vegetable yield (Table II). The results showed that vegetable crop combination exhibited significant influence on vegetable yield. In vegetable production together with transplanted aman rice cv. BINA Dhan-7 the highest vegetable yield (21.33 t ha$^{-1}$) was recorded from rice + bottle gourd (T$_1$) and the lowest yield (0.25 t ha$^{-1}$) was recorded from rice + cucumber (T$_5$) which was identical to (0.85 t ha$^{-1}$) found in T$_3$.

Rice Equivalent Yield (REY)

There was significant effect of crop combination on rice equivalent yield (Table II). Results showed that rice + bottle gourd (T$_1$) gave the highest rice equivalent yield (23.98 t ha$^{-1}$) and the lowest value (3.48 t ha$^{-1}$) was obtained from rice + cucumber (T$_3$) crop combination.
Table II. Vegetable yield and rice equivalent yield of transplanted *aman* rice cv. BINA Dhan-7 as influenced by rice-cum vegetable cultivation system

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Vegetable yield (t ha(^{-1}))</th>
<th>Rice equivalent yield (t ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>T(_1)</td>
<td>21.33 a</td>
<td>23.98 a</td>
</tr>
<tr>
<td>T(_2)</td>
<td>15.10 b</td>
<td>16.76 b</td>
</tr>
<tr>
<td>T(_3)</td>
<td>0.85 cd</td>
<td>4.62 d</td>
</tr>
<tr>
<td>T(_4)</td>
<td>2.75 c</td>
<td>9.53 c</td>
</tr>
<tr>
<td>T(_5)</td>
<td>0.25 d</td>
<td>3.48 d</td>
</tr>
</tbody>
</table>

Level of significance

| CV%       | **  
9.86     | **  
7.97     |

Columns having the similar letters means that treatments do not differ significantly, and dissimilar letters mean that treatments differ significantly by Duncan's Multiple Range Test (DMRT) at P ≤ 5%.

* = 5% level of significance

** = 1% level of significance

ns = not significant

CV = Coefficient of variance

Note:

T\(_1\) = rice + bottle gourd
T\(_2\) = rice + white gourd
T\(_3\) = rice + yard long bean
T\(_4\) = rice + bitter gourd
T\(_5\) = rice + cucumber

Economic Analysis

Total Cost of Production

The input costs, overhead costs and total cost of production of vegetable-rice production system was assessed. It was observed that vegetable cultivation on the edges of rice plot involved extra expenditure that was marginally higher than only rice cultivation. From economic analysis, it was found that the total cost of production for rice + bottle gourd (T\(_1\)) cultivation was the highest (Tk. 94384 ha\(^{-1}\)) and the lowest total cost of production (Tk. 61264 ha\(^{-1}\)) was recorded from the treatment (T\(_3\)) rice + yard long bean cultivation (Table III). Higher cost of production was found due to higher dose of fertilizers and seed cost for bottle gourd cultivation.

Gross Return

Gross return is an important indicator either crop cultivation is profitable or not. In vegetable cultivation with transplanted *aman* rice, the highest value of gross return (Tk. 316290 ha\(^{-1}\)) was obtained from the T\(_1\) treatment (rice + bottle gourd). On the other hand, the lowest value of gross return (Tk. 50835 ha\(^{-1}\)) was recorded from the treatment T\(_5\) (rice + cucumber) (Table III). The highest gross return was obtained due to higher vegetable yield of bottle gourd along with transplanted *aman* rice.

Net Return

Results presented in the Table III showed that the net return is comparatively higher in producing bottle gourd than white gourd on the edges of transplanted *aman* rice. It was observed that the T\(_1\) treatment (rice + bottle gourd) gave the highest net return (Tk. 221906 ha\(^{-1}\)) over total cost of production. At the same time, the lowest net return (Tk. 20611 ha\(^{-1}\)) was received from the T\(_5\). Higher net return was the result of higher gross return from the vegetable cultivation together with rice.

Benefit Cost Ratio

The economic analysis indicated that the highest benefit-cost ratio of 3.35 was recorded from C\(_1\) treatment (rice + bottle gourd) followed by T\(_2\) (2.09) treatment (Table III). The lowest benefit-cost ratio (0.71) was observed in T\(_5\) treatment (rice + cucumber). The benefit-cost ratio was higher in bottle gourd cultivation with transplanted *aman* rice due to higher gross return over total cost of production.
Table III. Cost and return of vegetable cultivation along with transplanted aman rice cv. BINA Dhan-7 in rice cum vegetable cultivation system

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total cost of production (Tk. ha(^{-1}))</th>
<th>Return (Tk. ha(^{-1}))</th>
<th>Gross return (Tk. ha(^{-1}))</th>
<th>Net return (Tk. ha(^{-1}))</th>
<th>Benefit-cost ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>From main product</td>
<td>From by-product</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T(_1)</td>
<td>94384</td>
<td>311460</td>
<td>4830</td>
<td>316290</td>
<td>221906</td>
</tr>
<tr>
<td>T(_2)</td>
<td>90780</td>
<td>185960</td>
<td>5865</td>
<td>189825</td>
<td>99045</td>
</tr>
<tr>
<td>T(_3)</td>
<td>61264</td>
<td>58180</td>
<td>7500</td>
<td>65680</td>
<td>4416</td>
</tr>
<tr>
<td>T(_4)</td>
<td>79120</td>
<td>103500</td>
<td>6855</td>
<td>110355</td>
<td>31235</td>
</tr>
<tr>
<td>T(_5)</td>
<td>71446</td>
<td>42120</td>
<td>8715</td>
<td>50835</td>
<td>-20611</td>
</tr>
</tbody>
</table>

IV. CONCLUSIONS

From the findings of field research work, the trellis vegetables cultivation on the edges of transplanted aman rice is remunerative in terms of both yield and economic aspect. Finally, we can say bottle gourd and white gourd are the most suitable vegetables for combined cultivation on the edges of transplanted aman rice as compared to bitter gourd, yard long bean and cucumber.

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