Reprint **ISSN 1991-3036 (Web Version)**

International Journal of Sustainable Crop Production (IJSCP)

(*Int. J. Sustain. Crop Prod.*)

Volume: 10 **Issue: 4** **November 2015**

Int. J. Sustain. Crop Prod. 10(4): 1-9 (November 2015)

RICE CUM VEGETABLES PRODUCTION IN SAME PLOT TO ENSURE FOOD SECURITY

M.R. AMIN, K.M.M. ISLAM, S.M.S. AHMED, M.A. HASAN AND M.S. ISLAM

An International Scientific Research Publisher

Green Global Foundation©

Web address: http://ggfjournals.com/e-journals archive
E-mails: editor@ggfjournals.com and editor.int.correspondence@ggfjournals.com

ISSN-1991-3036 (Online)
Int. J. Sustain. Crop Prod. 10(4):1-9(November 2015)

RICE CUM VEGETABLES PRODUCTION IN SAME PLOT TO ENSURE FOOD SECURITY

M.R. AMIN[1*], K.M.M. ISLAM[2], S.M.S. AHMED[2], M.A. HASAN[1] AND M.S. ISLAM[1]

[1]Department of Agronomy, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh;
[2]Faculty of Agriculture, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh.

*Corresponding author & address: Md. Ruhul Amin, E-mail: kbd.ruhul@gmail.com
Accepted for publication on 5 October 2015

ABSTRACT

Amin MR, Islam KMM, Ahmed SMS, Hasan MA, Islam MS (2015) Rice cum vegetables production in same plot to ensure food security. *Int. J. Sustain. Crop Prod.* 10(4), 1-9.

The experiment was conducted at the Agronomy field of HSTU, Dinajpur in *Boro* rice season during January 2013 to June 2013 to observe the performance of different species of trellis-grown vegetables on the ails of growing rice field with regard to both productivity and profitability. Two factors (crop combination and intensity of vegetables) experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The results revealed that grain yield was the highest (7.24 t ha^{-1}) in rice + cucumber (C_5) and the lowest grain yield (6.07 t ha^{-1}) was found in rice + white gourd (C_2). One time vegetables production (I_1) produced the highest grain yield (6.93 t ha^{-1}) and the lowest grain yield (6.39 t ha^{-1}) was received from two times vegetables production (I_2). In terms of vegetables production, the maximum vegetables yield (32.00 t ha^{-1}) was obtained from rice + bottle gourd (C_1) and the minimum value (1.28 t ha^{-1}) was received from rice + yard long bean (C_3) crop combination and as cucumber (C_5) was severely damaged by rainfall its yield was not much remarkable. The highest rice equivalent yield (38.75 t ha^{-1}) was found from rice + bottle gourd (C_1) crop combination and the lowest value (8.89 t ha^{-1}) was found from rice + yard long bean (C_3) crop combination. Among the treatment combination the highest vegetables yield (33.5 t ha^{-1}) and rice equivalent yield (41.18 t ha^{-1}) was recorded from C_1I_1 (rice + bottle gourd with one time vegetables cultivation) treatment combination. The lowest value of vegetables yield (0.925 t ha^{-1}) and rice equivalent yield (8.33 t ha^{-1}) was recorded from C_3I_2 treatment combinations. The highest benefit-cost ratio (3.94) was recorded from C_1I_1 treatment combination (rice + bottle gourd with two times vegetables cultivation) and the lowest benefit-cost ratio (1.03) was observed in C_5I_1 treatment combination (rice + cucumber with one time vegetables cultivation).

***Key words**: rice, vegetables, production, benefit-cost ratio*

INTRODUCTION

Rice (*Oryza sativa*) is the unique crop of great antiquity and heart rhythm of Bangladesh agriculture, as it is the staple food crop covering 74.28% of the total land area (BBS 2007). It occupies about 76% of the total cropped area. 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 of Bangladesh (Bhuiya and Hossain, 1994). Bangladesh is a small country of the third world with huge amount of population. Rice is grown in the *Aus*, *Aman* and *Boro* seasons in Bangladesh. Rice holds the area of 10.58 million hectares with a production of 26.53 million tons of grain with the average grain yield of only 2.58 t ha^{-1} (BBS 2007). Sustainable vegetables production system in Bangladesh is lacking. Vegetables crops excluding potato occupy only 1.8% of the total cropped area with a gross production of only 1.63 m tons (BBS 2004). To provide balance diet for the people of Bangladesh, there would be no alternative to vegetables production, as this would also be provide vitamins and minerals. Increasing the total land area for vegetables production in Bangladesh seems to have little scope, because of decreasing trend in the land-man ratio. In context of the growing demand for food, an additional need to raise crop production per unit area is being felt seriously. Therefore, the only avenue left is to increase the production of crops through intensive care, management and adoption of new dimension of technologies.

Now, in order to increase and stabilize agricultural production the means that has greatly received the attention of scientists in the recent years is multiple cropping or intercropping. In this form of production practice, more than one crop is grown simultaneously or in sequence on the same piece of land (Harwood 1973). The intercropping may provide an 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 vegetables 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.

Thus in these circumstances, in addition to using the conventional methods, the production of vegetables should also be trialed by adopting some unconventional methods. For example, growing several vegetables crops on the *ail*s (the border of rice plots that is used mainly for control of water movement is popularly known as ails all over Bangladesh) of rice crops may be explored. Moreover, the vegetables crops may be cultivated on the raised ails along one side of the rice plot so that there would be a little competition between rice and vegetables for several aspects of growth and developmental parameters. Therefore, if adequate quantities of vegetables can be grown on trellis without having any affect or causing a little affect to grow rice crops underneath, it would be a useful technology for the poor people of the country to fulfill their nutritional needs of vegetables and at the same time, to make the rice production a system-based, cost effective and hence, more profitable. From the above points of view, the experiment was undertaken to find out the most suitable types from the different veg-

etables crops to be raised simultaneously with *Boro* rice crop and to evaluate the over-all production of rice and their relative profitability of the rice plus production system compared to sole rice cropping.

MATERIALS AND METHODS

The experiment was carried out at the Agronomy field of HSTU, Dinajpur during the period of January 2013 to June 2013 to observe the performance of vegetables (bottle gourd, white gourd, yard long bean, bitter gourd and cucumber) production with *Boro* rice cv. BRRI dhan29 in respect of both yield and economical view point.

Treatments of the Experiment and Experimental Design

The experiment was laid out in a randomized complete block design with three replications. The treatment included in this experiment were three types i.e. Growing on the *ail*s of rice plots once in *Boro* rice (I_1), Growing on the *ail*s of rice plots twice in *Boro* rice (I_2), growing on the *ail*s of rice plots thrice in *Boro* rice (I_3) and five crop combinations i.e. rice + bottle gourd (C_1), rice + white gourd (C_2), rice + yard long bean (C_3), rice + bitter gourd (C_4) and rice + cucumber (C_5). All were cultivated on the trellis made along with the *ail*s of *Boro* rice field.

Preparation of Experimental Plot

The land was thoroughly ploughed on 25 January 2013 with a tractor driven disc plough followed by harrowing. *Boro* rice cv. BRRI dhan29 was fertilized with 130, 50, 85, 60 and 20 kg ha^{-1} of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate, respectively. Uprooting of seedlings, transplanting rice seedlings, intercultural operations for rice, gap filling, water management, weeding, plant protection measures, sampling, harvesting and processing of rice all were done accordingly as and when necessary.

Cultural Operation

Preparation of *ail*

In this experiment *ail*s of the rice field were used for vegetables cultivation. For this the *ail*s were specially prepared. The *ail*s were raised at North-South direction. All the *ails* were 50 cm width, 3 m long and 25 cm in height. The *ail*s were raised up to that height in order to avoid any root damage of vegetables seedlings due to water stagnancy of *Boro* rice field.

Fertilization

The following fertilizers with doses were used. Cow dung, urea, triple super phosphate and muriate of potash were well mixed with soil at time of *ail* preparation. Urea was applied in ring form around the base of the growing vegetables seedlings and rate varied to the need of the vegetables crop under question.

Name of the Vegetables	Amount of fertilizers and manures (g/pit)			
	Cow dung	Urea	TSP	MP
Bottle gourd	2000	50	50	50
White gourd	2000	30	50	30
Yard long bean	350	6	3	6
Bitter gourd	1000	20	25	30
Cucumber	2000	15	25	15

Raising vegetables seedlings, transplanting of vegetables seedlings on the *ail*s and other Intercultural operations for were done accordingly.

Harvesting

Bitter gourds were harvested first at 50-60 DAT and it was continued at intervals of 6 to 7 days. In case of yard long bean, first harvesting was done at 50 DAT and was harvested several times at 5 days intervals from the initial harvest. Bottle gourd and White gourd were harvested first at 70 to 80 DAT and it was done regularly at 10 to 12 days intervals.

Recording Data for BRRI dhan29

From the five randomly selected rice hills of each plot, data were recorded on 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}), and biological yield (t ha^{-1}).

Harvest Index

Harvest index denotes the ratio of economic yield to biological yield and was calculated with the following formula (Gardner *et al*. 1985).

Harvest index (%) = Grain yield/Biological yield x 100

Yield

After harvesting, the vegetables yields were calculated and converted to t ha^{-1}. Here, yield assessment was made not on the basis of area on which vegetables were grown but on the basis of whole plot.

Rice Equivalent Yield

The quantity of *Boro* rice that could be purchased by selling of vegetables obtained from the experimental plots under the existing market price was considered as the rice equivalent yield (REY). Rice equivalent yield was determined by the following formula suggested by Anjeneyula *et al*. (1989) as follows:

$$REY = Yr\ (kg\ ha^{-1}) + \frac{Yv(kg\ ha^{-1}) \times Pv\ (Tk.Kg^{-1})}{Pr\ (Tk.Kg^{-1})}$$

Where,

Rice equivalent yield (REY), Yield of rice crop (Yr), Yield of vegetables crop (Yv), Price of vegetables crop (Pv), and Price of rice crop (Pr)

Economic Analysis

Total man required for different operations were recorded along with cost of different variable inputs to find out the total variable cost of production of the crop produced by treatments. Total cost of production, gross return, net return and benefit-cost ratio (BCR) were also calculated on the basis of prevailing market price of the rice grain, rice straw and vegetables at harvest. BCR was calculated with the following formula (Islam *et al*. 2004).

$$Benefit\text{-}cost\ ratio = \frac{Gross\ return\ (Tk.ha^{-1})}{Total\ cost\ of\ production\ (Tk.ha^{-1})}$$

Statistical Analysis

Data obtained from the experiment for each parameter were analyzed following technique as designed by the computerized MSTATC programme. The mean differences among the treatments were adjusted with Duncan's Multiple Range Test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Results obtained from the present study have been presented and discussed below.

Plant Height

The highest plant height (98.41 cm) was found from the treatment combination rice + cucumber (C_5) and the lowest plant height (94.54 cm) was found from the treatment rice + bottle gourd (C_2) (Table 1). The result also supported by the findings of Saha (2002). The highest plant height (97.38 cm) was found from the treatment one time vegetables production (I_1) which was similar to treatment I_3 and the lowest plant height (95.81 cm) was found from the treatment two times vegetables production (I_2) (Table 2). The highest plant height (100.67 cm) was found from the treatment combination of C_1I_1 and the lowest plant height (91.67 cm) was found from the treatment combination of rice + bottle gourd with three times vegetables production (C_3I_3) (Table 3).

Number of Total Tillers $Hill^{-1}$

The results showed that the highest number of total tillers $hill^{-1}$ (22.22) was found in the treatment combination of rice + cucumber (C_5) and the lowest number of total tillers $hill^{-1}$ (17.22) was found in the treatment combination of rice + yard long bean (C_3) (Table 1). The highest number of total tillers $hill^{-1}$ (19.27) was found at treatment one time vegetables production (I_1) and the lowest number of total $hill^{-1}$ (17.67) was found from the treatment two times vegetables production (I_2) (Table 2). Numerically the highest total number of tillers $hill^{-1}$ (22.53) was found from the treatment combination of C_5I_1 and the lowest total number of tillers $hill^{-1}$ (15.67) was found from the treatment combination of rice + bottle gourd with three times vegetables production (C_3I_3) (Table 3).

Number of Fertile Tillers $Hill^{-1}$

The results showed that highest number of fertile tillers $hill^{-1}$ (21.67) was found from the treatment combination rice + cucumber (C_5) and the lowest number of fertile tillers $hill^{-1}$ (15.00) was found from the treatment rice + bitter gourd (C_4) (Table 1). The result was in agreement with the result of Saha (2002). The highest number of fertile tillers $hill^{-1}$ (17.80) was found from the treatment one time vegetables production (I_1) and the lowest number of fertile tillers $hill^{-1}$ (16.73) was found from the treatment three times vegetables production (I_3) which was similar to I_2 treatment (Table 2). Numerically the highest number of fertile tillers $hill^{-1}$ (22.33) was found from the treatment combination of rice + cucumber (C_5) with one time vegetables cultivation (C_5I_1) and the lowest number of fertile tillers $hill^{-1}$ (14.67) was found from the treatment rice + bottle gourd with three times vegetables cultivation (C_4I_3) (Table 3).

Table 1. Yield and yield attributes of *Boro* rice cv. BRRI dhan29 as influenced by the crop combination in the rice cum vegetables cultivation system

Crop combination	Plant height (cm)	Total tillers hill^{-1} (no.)	Fertile tillers hill^{-1} (no.)	Panicle length (cm)	Total grains panicle^{-1} (no.)	Filled grains panicle^{-1} (no.)	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
C_1 (R + B_0)	97.53	18.00	16.89b	25.33	212.56	194.78b	22.46	6.75ab	7.18bc
C_2 (R + W)	94.54	18.00	16.89b	25.28	211.56	192.67b	22.32	6.07c	6.23d
C_3 (R + Y)	95.42	17.22	15.78b	25.91	208.11	184.56b	22.05	6.22b	6.89c
C_4 (R + Bi)	97.66	18.22	15.00b	26.07	210.33	203.33b	21.97	6.72ab	7.00bc
C_5 (R + C)	98.41	22.22	21.67a	26.43	229.00	227.67a	22.20	7.24a	7.49a
Level of significant	NS	NS	0.01	NS	NS	0.01	NS	0.01	0.01
CV (%)	5.30	13.90	11.73	5.41	10.44	10.21	7.63	10.08	6.86

In a column, the treatment means having similar letter(s) do not differ significantly, NS = Not Significant, CV = Coefficient of Variance

Table 2. Yield and yield attributes of *Boro* rice cv. BRRI dhan29 as influenced by the intensity of vegetables in the rice cum vegetables cultivation system

Intensity of vegetables	Plant height (cm)	Total tillers hill^{-1} (no.)	Fertile tillers hill^{-1} (no.)	Panicle length (cm)	Total grains panicle^{-1} (no.)	Filled grains panicle^{-1} (no.)	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
I_1	97.38	19.27	17.80	26.11	223.87a	207.93	22.90	6.93	7.23a
I_2	95.81	17.67	17.20	25.49	209.47ab	199.07	21.96	6.39	6.46c
I_3	97.38	18.07	16.73	25.81	203.60b	194.80	21.73	6.48	7.09b
Level of significant	NS	NS	NS	NS	0.05	NS	NS	NS	0.01
CV (%)	5.30	13.90	11.73	5.41	10.44	10.21	7.63	10.08	6.86

In a column, the treatment means having similar letter(s) do not differ significantly
NS = Not Significant

Table 3. Yield and yield attributes of *Boro* rice cv. BRRI dhan29 as influenced by the interaction effect of crop combination and intensity of vegetables in the rice cum vegetables cultivation system

Crop combination × Intensity of vegetables	**Plant height (cm)**	**Total tillers hill^{-1} (no.)**	**Fertile tillers hill^{-1} (no.)**	**Panicle length (cm)**	**Total grains panicle^{-1} (no.)**	**Filled grains panicle^{-1} (no.)**	**1000 grain weight (g)**	**Grain yield (t ha^{-1})**	**Straw yield (t ha^{-1})**
$C_1 \times I_1$	100.67	19.33	17.67	25.13	235.00	219.33	23.82	7.68	8.35
$C_2 \times I_1$	95.17	18.33	17.33	26.27	224.00	211.00	22.93	6.13	6.41
$C_3 \times I_1$	97.73	18.33	16.33	26.27	215.33	189.33	22.42	6.46	6.78
$C_4 \times I_1$	97.83	19.33	15.33	26.17	214.33	196.33	23.07	6.48	6.80
$C_5 \times I_1$	95.50	22.53	22.33	26.73	230.67	223.67	22.27	5.69	5.83
$C_1 \times I_2$	92.67	17.67	17.00	25.00	205.00	189.33	21.76	6.03	6.25
$C_2 \times I_2$	93.47	17.00	16.00	24.37	203.67	181.00	22.65	6.10	6.50
$C_3 \times I_2$	96.87	17.67	16.00	26.27	199.00	191.00	22.05	6.40	6.86
$C_4 \times I_2$	96.27	16.67	15.00	25.67	211.67	204.67	21.13	6.16	6.55
$C_5 \times I_2$	99.80	22.33	22.00	26.13	232.67	229.33	22.24	6.69	7.02
$C_1 \times I_3$	99.27	17.00	16.00	25.87	197.67	175.67	21.81	6.22	6.75
$C_2 \times I_3$	95.00	18.67	17.33	25.20	207.00	186.00	21.37	7.25	7.50
$C_3 \times I_3$	91.67	15.67	15.00	25.20	197.33	173.33	21.67	7.69	8.92
$C_4 \times I_3$	98.87	18.67	14.67	26.37	214.67	209.00	21.71	7.51	8.57
$C_5 \times I_3$	99.93	21.33	20.67	26.43	235.33	230.00	22.10	6.51	6.92
Level of significant	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	5.30	13.90	11.73	5.41	10.44	10.21	7.63	10.08	6.86

In a column, the treatment means having similar letter(s) do not differ significantly

NS = Not Significant

Panicle Length

The highest panicle length (26.43 cm) was obtained from the treatment combination of rice + cucumber (C_5) and the lowest panicle length (25.28 cm) was found in rice + white gourd (C_2) crop combination (Table 1). The highest panicle length (26.11 cm) was found from the treatment one time vegetables production (I_1) and the lowest panicle length (25.49 cm) was found from two times vegetables production (I_2) (Table 2). The highest panicle length (26.73 cm) was found from the treatment combination of C_5I_1 and the lowest panicle length (24.37 cm) was found from the treatment combination of rice + white gourd with two times vegetables production (C_2I_2) (Table 3).

Number of Total Grains Panicle^{-1}

The highest number of grains panicle^{-1} (229.00) was found in the treatment combination of rice + cucumber (C_5) and the lowest number of grains panicle^{-1} (208.11) was found in the treatment of rice + bottle gourd (C_3) (Table 1). The highest number of grains panicle^{-1} (223.87) was found from treatment one time vegetables production (I_1) and the lowest number of grains panicle^{-1} (203.60) was found in three times vegetables production (I_3) (Table 2). The highest number of grains panicle^{-1} (235.33) was found from the treatment combination of rice + cucumber (C_5) with three times vegetables production (C_5I_3) and the lowest number of grains panicle^{-1} (197.67) was found from the treatment rice + bottle gourd with three times vegetables production (C_1I_3) (Table 3).

Number of Filled Grains Panicle^{-1}

The results showed that the highest number of filled grains panicle^{-1} (227.67) was found in the treatment rice + cucumber (C_5) and the lowest number of filled grains panicle^{-1} (184.56) was found in the treatment combination of rice + yard long bean (C_3) (Table 1). The highest number of filled grains panicle^{-1} (207.93) was found at one time vegetables production (I_1) and the lowest number of filled grains panicle^{-1} (194.80) was found in three times vegetables cultivation (I_3) (Table 2). The highest number of filled grains panicle^{-1} (230.00) was found from the treatment combination of rice + cucumber with three times vegetables cultivation (C_5I_3) and the lowest number of filled grains panicle^{-1} (173.33) was found from the treatment combination of rice + yard long bean (C_3I_3) (Table 3).

Weight of 1000 Grains

The highest weight of 1000- grains (22.46 g) was found in the treatment combination of rice + cucumber (C_1) and the lowest weight (21.97 g) of 1000- grains was observed in the treatment rice + bitter gourd (C_4) (Table 1). The results were in agreement with the result of Saha (2002). The highest 1000-grains weight (22.90 g) was recorded from the treatment one time vegetables production (I_1) and the lowest weight of 1000- grains was (21.73 g) produced by the treatment three times vegetables production (I_3) (Table 2). The highest weight of 1000 grains was (23.82 g) found in the treatment combination of rice + bottle gourd (C_1) with one time vegetables production (C_1I_1) and the lowest weight of 1000 grains (21.13 g) was found from the treatment rice + bitter gourd with two times vegetables production (C_4I_2) (Table 3).

Grain Yield of *Boro* rice cv. BRRI dhan29

The results showed that the highest grain yield (7.24 t ha^{-1}) was found in the treatment combination of rice + cucumber (C_5) and the lowest grain yield (6.07 t ha^{-1}) was found in the treatment rice + white gourd (C_2). The highest grain yield was found due to higher number of fertile tillers hill^{-1}, number of grains panicle^{-1} and 1000-grains weight (Table 1). These results are similar to the findings of Kundu (2002). The highest grain yield (6.93 t ha^{-1}) was found from the treatment one time vegetables production (I_1) which was similar to I_3 treatment and the lowest grain yield (6.39 t ha^{-1}) was found in two times vegetables production (I_2) (Table 2). The highest grain yield (7.69 t ha^{-1}) was found from the treatment combination of rice + Yard Long Bean (C_3) with three times vegetables production (C_3I_3) and the lowest grain yield (5.69 t ha^{-1}) was found from the treatment rice + cucumber with one time vegetables production (C_5I_1) (Table 3).

Straw Yield

The results showed that the highest straw yield (7.49 t ha^{-1}) was found in the treatment combination of rice + cucumber (C_5) and the lowest straw yield (4.13 t ha^{-1}) was found in the treatment rice + white gourd (C_2) (Table 1). The result was in agreement with the result of Hasan (2007).

The highest straw yield (7.23 t ha^{-1}) was found from the treatment one time vegetables production (I_1) and the lowest straw yield (6.46 t ha^{-1}) was found from the treatment two times vegetables production (I_2). The highest straw yield might be due to production of maximum number of total tillers per hill (Table 2). The result was similar to that of Amin (2004). The highest straw yield (8.92 t ha^{-1}) was found from the treatment combination of rice + cucumber (C_3) with three times vegetables production (C_3I_3) and the lowest straw yield (5.83 t ha^{-1}) was found from the treatment rice + cucumber with one time vegetables production (C_5I_1) (Table 3).

Biological Yield

The results showed that the highest biological yield (14.73 t ha^{-1}) was found in the treatment combination of rice + cucumber (C_5) and the lowest biological yield (12.30 t ha^{-1}) was found in the treatment rice + white gourd (C_2).

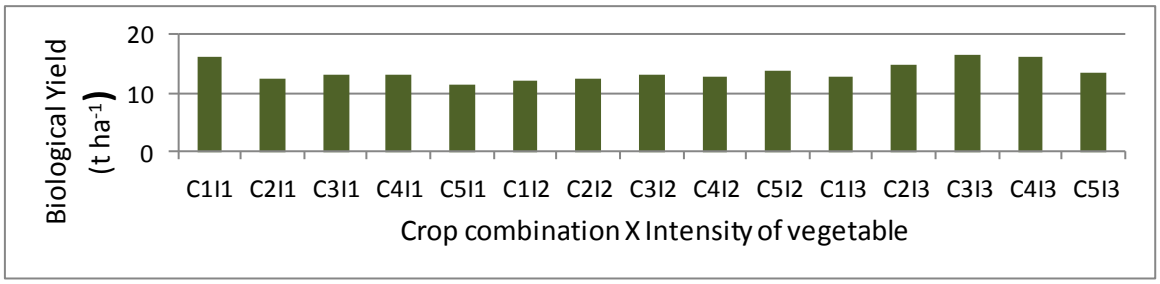

Fig. 1. Biological yield of *Boro* rice cv. BRRI dhan29 as influenced by the interaction effect of crop combination and intensity of vegetables cultivation system

The highest biological yield (14.16 t ha^{-1}) was obtained in one time vegetables production (I_1) and the lowest biological yield (12.79 t ha^{-1}) was found from two times vegetables production (I_2) (Table 2). The highest biological yield (16.61 t ha^{-1}) was found from the treatment combination of rice + yard long bean with three times vegetables production (C_3I_3) and the lowest biological yield (11.52 t ha^{-1}) was found from the treatment rice + white gourd with one time vegetables production (C_5I_1) (Fig. 1). The reason might be due to the production of higher level of grain and straw yields as compared to other treatments. The result was in agreement with the result of Hasan (2007).

Harvest Index

The highest value of harvest index (49.35%) was found in the treatment rice + white gourd (C_2). The lowest value of harvest index (47.44 %) was found in the treatment rice + yard long bean (C_3). The highest value of harvest index (49.96%) was found in two times vegetables production (I_2) and the lowest value of harvest index (47.75%) was found in the treatment three times vegetables production (I_3). The highest value of harvest index (49.39%) was found in the treatment rice + cucumber with one time vegetables production (C_5I_1) and the lowest value of harvest index (46.30%) was found in the treatment rice + yard long bean with three times vegetables production (C_3I_3).

Vegetables Yield

In vegetables production together with *Boro rice cv.* BRRI dhan29 the highest vegetables yield (32.00 t ha^{-1}) was recorded from rice + bottle gourd (C_1) and the lowest yield (1.28 t ha^{-1}) was recorded from rice + yard long bean (C_3) and as cucumber (C_5) was severely damaged by rainfall, its yield was not much remarkable. The highest vegetables yield (33.5 t ha^{-1}) was recorded from the treatment combination rice + bottle gourd with one time vegetables cultivation (C_1I_1) and the lowest yield (0.925 t ha^{-1}) was found from the treatment combination rice + yard long bean with two times vegetables cultivation (C_3I_2) (Table 4).

Rice Equivalent Yield (REY)

Results showed that rice + bottle gourd (C_1) gave the highest rice equivalent yield (38.75 t ha^{-1}) and the lowest value (8.89 t ha^{-1}) was obtained from rice + yard long bean (C_3) crop combination (Table 4).

Table 4. Vegetables yield and rice equivalent yield of *Boro* rice cv. BRRI dhan29 as influenced by the crop combination in the rice cum vegetables cultivation system

Crop combination	**Vegetables yield (t ha^{-1})**	**Rice equivalent yield (t ha^{-1})**
C_1 (R + Bo)	32.00	38.75
C_2 (R + W)	22.66	26.84
C_3 (R + Y)	1.28	8.89
C_4 (R + Bi)	4.13	17.05
C_5 (R + C)	0.00	7.24

The highest rice equivalent yield (41.18 t ha^{-1}) was obtained from (C_1I_1) treatment combination (rice + bottle gourd with one time vegetables cultivation) and the lowest rice equivalent (8.33 t ha^{-1}) was received from the treatment C_3I_2 (Table 5).

Table 5. Vegetables yield and rice equivalent yield of *Boro* rice cv. BRRI dhan29 as influenced by the interaction effect of crop combination and intensity of vegetables in the rice cum vegetables cultivation system

Treatments combination	Vegetables yield (t ha^{-1})	Rice equivalent yield (t ha^{-1})
C_1I_1	33.5	41.18
C_1I_2	30.5	36.53
C_1I_3	32	38.22
C_2I_1	18.5	23.09
C_2I_2	25.67	29.63
C_2I_3	23.8	29.07
C_3I_1	1.05	8.65
C_3I_2	0.925	8.33
C_3I_3	1.86	11.57
C_4I_1	3.35	14.86
C_4I_2	4.13	16.49
C_4I_3	4.92	19.81
C_5I_1	0.0000	5.69
C_5I_2	0.0000	6.69
C_5I_3	0.0000	6.51

Economic Analysis

Among the treatment combinations, it was found from the economic analysis that the highest benefit-cost ratio of 3.94 was recorded from C_1I_1 treatment combination (rice + bottle gourd with one time vegetables cultivation) followed by C_1I_3 (3.63), C_1I_2 (3.46), C_2I_2 (3.13), C_2I_3 (3.09) and C_4I_3 (2.47) treatment combination (Table 6). The lowest benefit-cost ratio (1.03) was observed in C_5I_1 treatment combination (rice + cucumber with one times vegetables cultivation).

Table 6. Cost and return of vegetables cultivation along with *Boro* rice cv. BRRI dhan29 in the rice cum vegetables cultivation system

Treatments combination	Total cost of production	Return (Tk. ha^{-1})		Gross return	Net return	Benefit-cost ratio
		From main product	From by-product			
C_1I_1	121705	468160	12525	480685	358980	3.94
C_1I_2	121705	412360	9375	421735	300030	3.46
C_1I_3	121705	432640	10125	442765	321060	3.63
C_2I_1	116423	277080	9615	286695	170272	2.46
C_2I_2	116423	355560	9750	365310	248887	3.13
C_2I_3	116423	349080	11250	360330	243907	3.09
C_3I_1	77030	103800	10170	113970	36940	1.47
C_3I_2	77030	99960	11250	111210	34180	1.44
C_3I_3	77030	138840	13380	152220	75190	1.97
C_4I_1	101141	178320	10200	188520	87379	1.86
C_4I_2	101141	197880	9825	207705	106564	2.05
C_4I_3	101141	237720	12855	250575	149434	2.47
C_5I_1	74217	68280	8745	77025	2808	1.03
C_5I_2	74217	80280	10530	90810	16593	1.22
C_5I_3	74217	78120	10380	88500	14283	1.19

Price: Bottle gourd @ Tk. 10 kg^{-1}, White gourd @ Tk. 11 kg^{-1}, Yard long bean @ Tk. 25 kg^{-1}, Rice grain @ Tk. 12 kg^{-1}, Bitter gourd @ Tk. 30 kg^{-1}, Rice straw @ Tk. 1.5 kg^{-1}

CONCLUSION

Results showed that vegetables cultivation with *Boro* rice crop is remunerative in terms of both yield and economical point of view. The results also indicated that bottle gourd and white gourd were the most suitable vegetables crops for such type of cultivation while bitter gourd was moderately suitable for cultivation with *Boro* rice and yard long bean was least suitable for cultivation with *Boro* rice.

REFERENCES

Amin AKMR (2004) Effect of cold temperature and agronomic management on the spikelet sterility and yield of *Boro* rice. Ph.D. Thesis, Department of Agronomy, Bangladesh Agricultural University, Mymensingh.

Anjeneyula VR, Singh SP, Ali M (1989) Effect of competition free period and technique and pattern of pearl millet planting in growth and yield of mungbean and total productivity in solid pearl millet/mungbean intercropping systems. *Indian Journl of Agronomy*, 24(3), 219-226.

BBS (Bangladesh Bureau of Statistics) (2004) Monthly Statistical Bulletin Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

BBS (Bangladesh Bureau of Statistics) (2007) Monthly Statistical Bulletin Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

Bhuiya MSU, Hossain SMA (1994) Sustainable maintenance of organic matter in rice farming with *Sesbania rostrata.* Annual Progressive Report 1993-94. Department of Agronomy, Bangladesh Agrilcultural University, Mymensingh.

Gardner FP, Pearce RB, Mistechell RL (1985) Physiology of Crop Plants. Lowa State University. Press, Iowa.

Gomez KA, Gomez AA (1984) Statistical Procedure for Agricultural Research. 2nd Edition, John Willey and Sons. New York. pp. 97-111.

Harwood RR (1973) The concept of multiple cropping. An introduction to the principles of cropping system design. Multiple training lectures.

Hasan MA (2007) Vegetables production on the *ail*s of rice field and its effects on rice crop. Ph.D. Thesis, Department of Agronomy, Bangladesh Agricultural University, Mymensingh.

Islam MA, Sharfuddin AFM, Islam N (2004) A study on production technology and disease management of ginger and turmeric in selected areas of Bangladesh. *Bangladesh J. Crop Sci.* (13-15), 103-110.

Kundu SK (2002) Vegetables production in *Boro* rice crop. M.S. Thesis, Department of Agronomy, Bangladesh Agricultural University, Mymensingh.

Saha P (2002) Vegetables production in T. Aman rice. M. S. Thesis, Department of Agronomy, Bangladesh Agrilcultural University, Mymensingh.