



## **System Productivity of Rabi Vegetables and Aman Rice varieties in Rabi Vegetables-Mungbean-Aman Rice Cropping Pattern**

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### **Abstract**

Field experiments were conducted during 2007-2010 to evaluate the agro-economic productivity of BRRI Aman rice varieties and Rabi vegetables at the Bangladesh Rice Research Institute (BRRI) in silty clay loam soil. Five Aman rice varieties having different growth durations and three winter vegetables viz., tomato, red amaranth and bush bean were evaluated in split plot design with three replications. Mungbean was grown in Kharif-I season. Rice varieties did not differ significantly in terms of grain yield ( $t\ ha^{-1}$ ). Among the three vegetables, the yields of tomato, red amaranth and bush bean were 35.02, 7.53 and 4.33  $t\ ha^{-1}$ , respectively. Average yield of Mungbean was 0.89  $t\ ha^{-1}$ . In case of rice equivalent yield (REY), Tomato-Mungbean-BRRI dhan33 cropping pattern produced comparatively high average REY (29.95  $t\ ha^{-1}$ ) followed by Tomato-Mungbean-BRRI dhan39 (27.33  $t\ ha^{-1}$ ) cropping pattern. Among the tested cropping patterns, Tomato-Mungbean-BRRI dhan33 and Tomato-Mungbean-BRRI dhan39 were more profitable than other patterns.

**Key words:** System productivity, cropping pattern, BRRI aman rice varieties, rabi vegetables

### **1. Introduction**

In Bangladesh, the rice-growing environment is classified into three major ecosystems based on physiography and land types: irrigated, rainfed, and floating or deepwater. The rainfed ecosystem has been further classified as rainfed lowland and rainfed upland. The modern and traditional Aman rice varieties are cultivated in rainfed ecosystem to meet up the food requirement. The modern varieties cover about 68% of rice area and rest of the area is covered by traditional varieties in Aman season (BRRI, 2011). Highland covers about 40% of the total land area of Bangladesh and its cropped area is about 18% of the total cropped area. In partially irrigated highland ecosystem T. Aman rice-Rabi

vegetables is a dominant cropping pattern (Elahi *et al.*, 2001; Khan *et al.*, 2004). Agro-economic productivity of this ecosystem is not so high. Though T. Aman is grown under rainfed condition, supplemental irrigation for land preparation and at reproductive stage is essential which increases the total cost of production. Moreover, for T. Aman rice establishment, land is prepared by puddling which compacts the soil and subsequently affects establishment and productivity of the next Rabi crops. Furthermore, long duration Aman rice varieties delayed vegetable planting. It is important that direct seeding of rice offer some advantages over conventional transplanting such as faster and easier establishment, reduced laborer and less drudgery and often higher profit

(Balasubramanian *et al.*, 2003) as well as decreases the growth duration of rice (Rashid *et al.*, 2008). Generally many early winter vegetable growing farmers keep their lands fallow in Kharif-II season which results in low cropping intensity. In this ecosystem after harvesting of vegetables, there is little option to grow another crop in Kharif-I season. Mungbean (*Vigna radiata*) is one of the most important pulse crops in Bangladesh in both area and production. Much area of mungbean is occupied by cereals (Abedin. *et al.*, 1991). Now a day, it is cultivated after harvesting of Rabi crops. A short duration summer mungbean may be included for increasing cropping intensity of this ecosystem. Therefore, this study was undertaken to evaluate the agro-economic productivity of five BRRI Aman rice varieties differing in their growth duration as direct seeding and three early winter vegetables in Vegetable-Mungbean-Aman cropping pattern in partially irrigated highland ecosystem.

## 2. Materials and Methods

The experiment was conducted at Bangladesh Rice Research Institute (BRRI) experimental farm (24° 0' N 30° 30'), Gazipur for three years from 2007 to 2010 during Kharif-II, Rabi and Kharif-I seasons. Five Aman rice varieties differing in their growth duration viz. BRRI dhan33 (118 days), BRRI dhan39 (122 days), BRRI dhan32 (130 days), BRRI dhan31 (140 days), and BRRI dhan44 (150 days) and three winter vegetables viz., tomato, red amaranth and bush bean were evaluated in split plot design with three replications. Mungbean was grown in Kharif-I season. Recommended management practices were followed for rice, vegetables and mungbean. Rice was sown on third week of June to first week of July and harvested in first to last week of October. Vegetables were established within first to third week of November. Harvesting of vegetables was started from first week of December and continued up to last week of February. Mungbean was sown from last week of February to second week of March and harvested up to third week of May. Yield of

different crops were compared in terms of total rice equivalent yield (REY). The REY was computed by converting yield of non rice crops into the yield of rice following Singh *et al.* (1993) as follows:

REY of the crop =

$$\frac{\text{Yield of A (kg ha}^{-1}\text{) X Market price of A (Tk kg}^{-1}\text{)}}{\text{Market price of B (Tk ha}^{-1}\text{)}}$$

Where,

A= vegetables and mungbean

B= rice

A simple cost and return analysis was done based on total variable cost and average yield of different crops of tested cropping patterns to evaluate the total productivity of Vegetables-Mungbean-Direct seeded Aman rice cropping systems.. Cost of cultivation and farm gate prices of the produces at harvesting were used to compute gross return, gross margin and benefit cost ratio (BCR). All the collected data related to cropping pattern were subjected to analysis of variation (ANOVA) with the help of computer “MSTATC” program. The means were compared by using Duncan’s Multiple Range Test (DMRT).

## 3. Results and Discussion

### 3.1. Direct seeded aman rice

Grain yield (t ha<sup>-1</sup>) of direct seeded Aman rice varieties did not vary significantly (Table 1). However, the highest grain yield was produced by BRRI dhan31 (4.49 t ha<sup>-1</sup>) followed by BRRI dhan39 (4.46 t ha<sup>-1</sup>) and BRRI dhan32 (4.35 t ha<sup>-1</sup>). Though the grain yields of BRRI dhan33 and BRRI dhan39 were lower than that of BRRI dhan31, the vegetable yields, irrespective of species, following these two varieties were higher, which resulted in significantly higher total REY. Moreover, red amaranth could be grown twice after BRRI dhan33 and BRRI dhan39 which contributed more to the total REY because these two are short duration varieties. (Adhunik Dhaner Chash, 2011).

**Table 1.** Yield of rice (t ha<sup>-1</sup>) in Vegetables-Mungbean-Direct seeded Aman rice cropping pattern

Rice variety	Vegetables			Mean
	Bush bean	Red amaranth	Tomato	
	2008	2009	2010	
BRR1 dhan31	4.34	4.54	4.59	4.49
BRR1 dhan32	4.01	4.85	4.19	4.35
BRR1 dhan33	4.29	3.80	4.69	4.26
BRR1 dhan39	4.29	4.27	4.83	4.46
BRR1 dhan44	4.17	3.87	3.7	3.91
Mean	4.22	4.26	4.40	4.30
CV (%)	8.52	7.02	11.00	-

**Table 2.** Yield of Vegetables (t ha<sup>-1</sup>) in Vegetables-Mungbean- Direct seeded Aman rice cropping pattern

Vegetables	Rice variety					Mean
	BRR1 dhan31	BRR1 dhan32	BRR1 dhan33	BRR1 dhan39	BRR1 dhan44	
	2008					
Bush bean	5.63 fg	5.40 g	6.43 efg	5.70 fg	5.56 g	5.74
Red amaranth	6.15 fg	6.21 fg	7.56 ef	8.21 e	6.45 efg	6.92
Tomato	33.23 bc	31.733 cd	33.76 ab	35.18 a	27.38 d	32.26
Mean	15.00	14.45	15.92	16.36	13.13	14.97
CV (%)	6.81	6.81	6.81	6.81	6.81	
	2009					
Bush bean	2.50 ki	4.53 jk	6.40 e	4.46 jk	2.00 l	4.35
Red amaranth	7.13 hi	9.13 gh	12.51 ij	9.56 fg	11.51 ef	9.97
Tomato	53.80 c	55.66 c	65.60 a	57.90 b	17.18 d	50.03
Mean	30.47	23.11	28.17	23.97	10.23	21.45
CV (%)	6.25	6.25	6.25	6.25	6.25	-
	2010					
Bush bean	2.64 de	3.28 de	2.79 de	3.54 de	2.24 e	2.90
Red amaranth	4.14 de	4.93 d	8.05 c	7.82 c	3.52 de	5.69
Tomato	19.03 b	24.34 a	26.23 a	26.46 a	17.79 b	22.77
Mean	8.62	10.9	12.4	12.58	7.9	10.5
CV (%)	11.55	11.55	11.55	11.55	11.55	

Figures in a column followed by different letters differ significantly at 5% level of significance by DMRT.

### 3.2. Vegetables

In case of yield of vegetables, tomato yielded significantly higher than other two vegetables in irrespective of rice varieties plot. Among the three vegetables, the yields of tomato, red

amaranth and bush bean were 32.26, 6.92 and 5.74 t ha<sup>-1</sup> in 2008; 50.23, 9.97 and 4.35 t ha<sup>-1</sup> in 2009; and 22.91, 6.49 and 2.91 t ha<sup>-1</sup> in 2010, respectively, irrespective of previous Aman rice varieties (Table 2). Accordingly, Tomato-Mungbean-Rice cropping pattern resulted in the

highest REY (18.83 t ha<sup>-1</sup>) though Red amaranth was grown twice after harvesting of BRRI dhan33 and BRRI dhan39. Among the main plots of five rice varieties, yield of vegetables was higher in BRRI dhan33 and BRRI dhan39 plots than in other three rice plots.

### 3.3. Mungbean

BARI Mungbean-6 was grown and yielded 0.59 to 1.03 t/ha. There was no significant yield difference in preceding vegetables plots (Table 3). Mungbean was grown as blanket crop, so it might have contributed to increase the total productivity of the cropping systems.

### 3.4. Rice equivalent yield (REY)

The interaction effects of rice varieties and vegetables were significant for total REY of different cropping patterns (Table 4). The cropping pattern Tomato-Mungbean-BRRI

dhan33 produced higher REY (29.95 t ha<sup>-1</sup>) followed by Tomato-Mungbean-BRRI dhan39 (27.33 t ha<sup>-1</sup>) cropping pattern (Table 5). On the contrary, the lowest REY (8.29 t ha<sup>-1</sup>) recorded in Bush bean-Mungbean-BRRI dhan44 cropping pattern followed by Bush bean-Mungbean-BRRI dhan31 cropping pattern.

### 3.5. Economic productivity

The Total variable cost (TVC) for tomato was 89,331 Tk ha<sup>-1</sup> which was higher than that for other crops (Table 6). In case of cropping pattern, the highest TVC was incurred for Tomato-Mungbean-Rice cropping pattern followed by Bush bean-Mungbean-Rice cropping pattern. The highest gross return, gross margin and benefit cost ratio (BCR) of 5,39,100 Tk ha<sup>-1</sup>, 3,97,340 Tk ha<sup>-1</sup> and 3.80, respectively, were obtained from Tomato-Mungbean- BRRI dhan33 followed by Tomato-Mungbean-BRRI dhan39 cropping pattern (Table 7).

**Table 3.** Yield of Mungbean (t ha<sup>-1</sup>) in Vegetables-Mungbean- Direct seeded Aman rice cropping pattern

Vegetables	Rice variety					Mean
	BRRI dhan31	BRRI dhan32	BRRI dhan33	BRRI dhan39	BRRI dhan44	
2008						
Bush bean	1.05	0.88	1.08	1.02	0.98	1.00
Red amaranth	0.88	0.93	1.00	0.86	0.97	0.93
Tomato	1.05	1.09	1.05	0.94	1.01	1.03
Mean	0.99	0.97	1.04	0.94	0.99	0.99
CV (%)	6.81	6.81	6.81	6.81	6.81	-
2009						
Bush bean	0.86	0.88	0.87	0.90	0.89	0.88
Red amaranth	1.04	1.08	1.01	0.88	1.05	1.01
Tomato	0.92	1.03	1.03	1.02	1.01	1.00
Mean	0.94	1.00	0.97	0.93	0.98	0.96
CV (%)	5.82	5.82	5.82	5.82	5.82	5.82
2010						
Bush bean	0.87	0.98	0.85	1.13	0.64	0.89
Red amaranth	0.48	0.72	0.95	1.07	0.69	0.71
Tomato	0.61	0.63	0.53	0.54	0.63	0.59
Mean	0.65	0.78	0.78	0.84	0.65	0.73
CV (%)	10.24	10.24	10.24	10.24	10.24	-

**Table 4.** Rice Equivalent Yield (REY, t ha<sup>-1</sup>) of Vegetables-Mungbean- Direct seeded Aman rice cropping pattern

Vegetables	Rice variety					Mean
	BRRIdhan31	BRRIdhan32	BRRIdhan33	BRRIdhan39	BRRIdhan44	
2008						
Bush bean	10.67 de	9.90 e	10.87 de	11.32 de	11.10 de	10.77
Red amaranth	13.04 cd	12.59 cd	14.21 c	13.01 cd	13.06 cd	13.18
Tomato	25.63 a	24.68 a	25.97 a	26.46 a	21.98 b	24.94
Mean	16.45	15.72	17.02	16.93	15.38	16.30
CV (%)	7.81	7.81	7.81	7.81	7.81	-
2009						
Bush bean	8.84 f	10.36 def	10.18 def	9.21 ef	7.90 f	9.30
Red amaranth	10.92 def	12.36 d	13.19 d	12.09 de	12.75 d	12.26
Tomato	37.01 b	36.97 b	43.12a	39.27 b	16.23 c	34.52
Mean	18.92	19.90	22.16	20.19	12.29	18.69
CV (%)	8.69	8.69	8.69	8.69	8.69	-
2010						
Bush bean	7.40 g	7.39 g	8.89 f	9.10 f	5.87 h	7.73
Red amaranth	9.31 f	9.67 f	11.55 e	12.32 e	6.45 gh	9.86
Tomato	16.26 c	18.83 b	20.76 a	21.00 a	14.35 d	18.24
Mean	10.99	11.96	13.73	15.72	8.89	11.94
CV (%)	6.82	6.82	6.82	6.82	6.82	-

Figures in a column followed by different letters differ significantly at 5% level of significance by DMRT.

Price at harvesting time (Tk kg<sup>-1</sup>): Rice = 18.00, Tomato = 10.00, Red amaranth and Bushbean = 10.00, Mungbean = 50.00.

**Table 5.** Pattern wise Rice Equivalent Yield (REY, t ha<sup>-1</sup>) from 2008-2010

Vegetables	Cropping pattern		2008	2009	2010	Mean
	Mungbean	Rice				
Bush bean	Mungbean	BRRIdhan33	10.87 de	10.18 def	8.89 f	9.98
Red amaranth	Mungbean	BRRIdhan33	14.21 c	13.19 d	11.55 e	12.98
Tomato	Mungbean	BRRIdhan33	25.97 a	43.12a	20.76 a	29.95
Bush bean	Mungbean	BRRIdhan39	11.32 de	9.21 ef	9.10 f	9.88
Red amaranth	Mungbean	BRRIdhan39	13.01 cd	12.09 de	12.32 e	12.47
Tomato	Mungbean	BRRIdhan39	26.46 a	39.27 b	21.00 a	27.33
Bush bean	Mungbean	BRRIdhan32	9.90 e	10.36 def	7.39 g	9.22
Red amaranth	Mungbean	BRRIdhan32	12.59 cd	12.36 d	9.67 f	11.54
Tomato	Mungbean	BRRIdhan32	24.68 a	36.97 b	18.83 b	26.83
Bush bean	Mungbean	BRRIdhan31	10.67 de	8.84 f	7.40 g	8.97
Red amaranth	Mungbean	BRRIdhan31	13.04 cd	10.92 def	9.31 f	11.09
Tomato	Mungbean	BRRIdhan31	25.63 a	37.01 b	16.26 c	27.88
Bush bean	Mungbean	BRRIdhan44	11.10 de	7.90 f	5.87 h	8.29
Red amaranth	Mungbean	BRRIdhan44	13.06 cd	12.75 d	6.45 gh	10.75
Tomato	Mungbean	BRRIdhan44	21.98 b	16.23 c	14.35 d	17.52

Figures in a column followed by different letters differ significantly at 5% level of significance by DMRT.

**Table 6.** Total variable costs of cultivation of rice, vegetables and mungbean at BRRI, Gazipur

Item	Cost (Tk./ha)				
	Rice	Vegetables			Mungbean
		Tomato	Red amaranth	Bush bean	
Seed	1750	4200	400	12000	2400
Land preparation	4446	4446	4446 (1 <sup>st</sup> crop) 2223 (2 <sup>nd</sup> crop)	4446	2223
Fertilizer	5801	22520	4200	8874	4783
Irrigation	2000	4125	2475	2475	825
Insecticide	2344	--	--	--	--
Labor:					
Sowing/planting	1400	1120	700	1680	980
Weeding	7000	1680	980	5040	1400
Irrigation	840	3360	1680	1680	--
Harvesting, threshing, processing etc.	8960	10080	3920	4480	7280
Total	34541	89331	18801 (1 <sup>st</sup> crop) 16578 (2 <sup>nd</sup> crop)	40675	17891

**Table 7.** Economic productivity of different Vegetables-Mungbean-DS Aman rice cropping patterns at BRRI, Gazipur

Vegetable	Cropping Pattern		TVC (000 Tk ha <sup>-1</sup> )	Gross return (000 Tk ha <sup>-1</sup> )	Gross margin (000 Tk ha <sup>-1</sup> )	BCR
	Mungbean	Rice				
Bush bean	Mungbean	BRRI dhan33	93.1	179.64	86.54 (11)	1.93
Red amaranth	Mungbean	BRRI dhan33	87.81	233.7	145.89 (6)	2.66
Tomato	Mungbean	BRRI dhan33	141.76	539.1	397.34 (1)	3.80
Bush bean	Mungbean	BRRI dhan39	93.1	177.78	84.68 (12)	1.91
Red amaranth	Mungbean	BRRI dhan39	87.81	224.52	136.71 (7)	2.56
Tomato	Mungbean	BRRI dhan39	141.76	520.38	378.62 (2)	3.67
Bush bean	Mungbean	BRRI dhan32	93.1	165.9	72.8 (13)	1.78
Red amaranth	Mungbean	BRRI dhan32	71.23	207.72	136.49 (8)	2.92
Tomato	Mungbean	BRRI dhan32	141.76	482.88	341.12 (3)	3.41
Bush bean	Mungbean	BRRI dhan31	93.1	161.46	68.36 (14)	1.73
Red amaranth	Mungbean	BRRI dhan31	71.23	199.62	128.39 (9)	2.80
Tomato	Mungbean	BRRI dhan31	141.76	473.4	331.64 (4)	3.34
Bush bean	Mungbean	BRRI dhan44	93.1	149.22	56.12 (15)	1.60
Red amaranth	Mungbean	BRRI dhan44	71.23	193.56	122.33 (10)	2.72
Tomato	Mungbean	BRRI dhan44	141.76	315.36	173.6 (5)	2.22

Figures in the parentheses indicate rank of different cropping patterns.

Price at harvesting time (Tk kg<sup>-1</sup>): Rice = 18.00, Tomato = 10.00, Red amaranth and Bush bean = 10.00, Mungbean = 50.00.

#### 4. Conclusions

Direct seeding of short duration Aman rice BRRI dhan33 and BRRI dhan39 were more suitable for growing vegetables in the following season. In spite of high production cost, the highest return was obtained from tomato after direct seeding rice and mungbean could be grown successfully in the next Kharif-I season. Tomato-Mungbean- BRRI dhan33 and Tomato-Mungbean-BRRI dhan39 cropping patterns were more profitable which were followed by Tomato-Mungbean-BRRI dhan32 and Tomato-Mungbean-BRRI dhan31 cropping patterns.

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