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Economic evaluation of mixed cropping of Mungbean with off-season Tossa jute seed crop

Md. Nahid Parvez[1], Md. Shafiqul Islam[2], Tamanna Haque[3], Fakir Muhammad Munawar Hossain[4] and Najrul Islam[2]

[1]Dept. of Agriculture, First Capital University of Bangladesh, Chuadanga
[2]Dept. of Agronomy, Bangladesh Agricultural University of Bangladesh, Mymensingh
[3]Dept. of Horticulture, Bangladesh Agricultural University of Bangladesh, Mymensingh
[4]Planning Commission, Government People's Republic of Bangladesh, Dhaka, Bangladesh

✉ For any information: ask.author@journalbinet.com, Available online: 25 February 2017.

ABSTRACT

Field experiments were conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University to identify the most profitable mixed cropping sequence of mungbean with off season Tossa jute. Experiment was laid out in a Randomized Complete Block Design with three replications, consisting of fourteen treatments. Results showed that plant population at harvest, plant height, branches plant^{-1}, seed yield and 1000-seed weight of jute were reduced in mixed cropping treatments as compared with sole cropping of jute. As a result, the seed yield of sole jute crop was always higher than that of mixed cropping treatments. The highest seed yield of jute was 485.5 kg ha^{-1} as sole cropping treatment and lowest seed yield of jute 122.5kg ha^{-1} was obtained in 80% mungbean+20% jute treatment. However, the highest land equivalent ratio (1.16) and monetary advantage (Tk 11724.13 ha^{-1}) were found in of 100% mungbean+80% jute treatment which also gave the higher economic return than sole jute seed crop. Therefore, the seed yield of jute and mungbean at mixed cropping under variable seeding rates were less than their sole crop yields but the combined yields or equivalent yields of jute and mungbean from mixed cropping were more than the sole crop yield of either jute or mungbean. Thus mixed cropping of mungbean and jute appeared to be the best practice in terms of economic return to the farmers.

Key Words: *Jute seed crop, Mungbean, Mixed cropping, Benefit cost ratio (BCR) and Land equivalent ratio (LER)*

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I. Introduction

Jute (*Corchorus olitorius*) is known as golden fibre and one of the important cash crops of Bangladesh. It has capacity of higher carbon monoxide (CO) assimilation rate in era of environmental concern. Among the jute growing countries of the world, Bangladesh ranks second in respect of production [8].

In 2014-2015, 7.501 million tons of jute were produced from 6.72 million hectare of lands [4]. To cultivate the said area the farmers require about 30 thousand tons of seed per year. Jute farmers of Bangladesh use their land to produce seed following the traditional practice to meet up their own requirements. But, the main problem in Bangladesh is the non availability of quality seed at proper time of sowing. Since jute plays a vital role in the economy of Bangladesh, an adequate amount of quality seed is necessary for producing jute fibre. Farmers of Bangladesh do not like to cultivate jute seed crop due to its high cost, poor return and low seed yield as compared to other competing cereal crops. They mainly grow the crop for the fibre and a portion of the crop usually kept at the corner or at the end of the field for the production of seeds. The area covered in this way is very low. Besides, sometimes it is damaged by flood water or heavy rainfall or other natural hazards. Seed producing organization like Bangladesh Agricultural Development Corporation (BADC) produces only 10-15% of the total requirement of jute seed of the country. So, the scarcity of jute seed arises in the sowing period every year. Recently, Bangladesh Jute Research Institute (BJRI) has developed late season jute seed production technology, the jute seed yield by this late sowing is 3-5 times higher than that obtained from the fibre season. Since the land area in our country is limited in relation to the population, the horizontal expansion of cropping area is not possible. Intensive crop culture is the only way to increase crop production to attain self-sufficiency in food production. Use of modern cultivars, balanced fertilization, judicious cultural practices and adoption of multiple cropping systems are the major ways for crop intensification. At present, multiple cropping has been gaining importance to increase more crop production in limited land area particularly in the countries with small size farm holdings/capita. Mungbean (*Vigna radiata*) is the important pulse crop of Bangladesh. The cultivation of mungbean is about 96000 acre of land and total production is 33000m ton [4]. Several studies conducted in relation to mixed cropping evidenced that the combination of jute and mungbean intercrop was found to be highly satisfactory as evidenced from the report of BJRI, 1986 in Bangladesh [6] and that of Patel and Mitra (1997) in India [13]. The growing of late season jute seed crop and mungbean is the same. Mungbean can be grown throughout the year. If mixed cropping of mungbean as pulse crop could be done with late season jute seed crop then the scarcity of jute seed in the country may be minimized. On the other hand, pulse crops will add additional benefit to the farmer. Therefore, the present study was undertaken to evaluate the agronomic performance of mungbean mixed cropping with late season jute seed crop, find out the economic feasibility of mungbean and jute seed crop and land equivalent ratio (LER).

II. Materials and Methods

Experiment was conducted at Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from September 2008 to February 2009. The experimental plot is located at 24.750° N Latitude and 90.50° E Longitude at an altitude of 18 m above the sea level. The experiment was laid out in a Randomized Complete Block Design with three replications. The following treatments were included in the experiment.

T1 =Sole jute	T6 =100% mungbean+80% jute	T11 =60% mungbean+20% jute
T2 =Sole mungbean	T7 =80% mungbean+20% jute	T12 =60% mungbean+40% jute
T3 =100% mungbean+20% jute	T8 =80% mungbean+40% jute	T13 =60% mungbean+60% jute
T4 =100% mungbean +40% jute	T9 =80% mungbean+60% jute	T14 =60% mungbean+80% jute
T5 =100% mungbean+60% jute	T10 =80% mungbean+80% jute	

Experiment includes two types of crops. Jute (*Corchorus olitorius* , var. O-9897 i.e. Falguni Tossa) was the principal seed crops and mungbean (*Vigna radiata*, var. BARI Mung 5) as pulse crops. The soil was sandy loam in texture and slightly acidic in nature, moderate in organic matter content and low in fertility level. The status of P and CEC is medium and that of K is low [3]. The experiment was initiated on September 2008 by ploughing the land. The seeds were sown on October 15, 2008 as sole and mixed cropping. The unit plot size was 4m×2.5m. The seed and fertilizer rates of mungbean and jute were recommended in the case of sole cropping by Bangladesh Agricultural Research Institute and Bangladsh Jute Research Institute respectively. One half of total urea and full dose of TSP, MP and gypsum were applied after first ploughing of the experimental plots. The remaining half of Urea was top dressed in two equal splits, on 35 and 45 days after sowing (DAS) in sole mungbean, jute and mixed cropping treatments. The following data were recorded before and after harvest both for sole and mixed crops treatments i.e. Plant population m^{-2}. Plant height (m), number of branches $plant^{-1}$, number of pods (fruits) plant^{-1}, number of seeds pod^{-1}, seed yield ha^{-1} (kg), 1000 seed weight (g), Percentage of viable seeds, Disease and pest incidence, By product yield ha^{-1} (kg), Economic return and Benefit Cost Ratio (BCR).

Relative yields were calculated by dividing the yield of jute and mungbean mixed crops with their respective sole crop yields [1].

$$\text{Relative yield} = \frac{\text{Mixed crop yield of jute / mungbean}}{\text{Sole crop yield of jute / mungbean}}$$

Jute seed equivalent yield was calculated and it was computed by converting the yield of mungbean into the yield of jute seed on the basis of prevailing market prices using the following formula [2]:

$$\text{Jute seed equivalent yield} = Yj + \frac{Ymu \times Pmu}{Pj}$$

Where,

Y_{mu}=Yield of Mungbean (mixed crop) kg/ha; Y_J=Yield of jute (mixed crop) kg/ha
P_{mu}=Price of Mungbean (Tk/kg); P_J=Price of jute (Tk/kg)

To evaluate the productivity advantage of mixed crops LER was calculated with the following formula [10]:

$$\text{LER} = \frac{\text{Mixed crop yield of jute}}{\text{Sole crop yield of jute}} + \frac{\text{Mixed crop yield of Mungbean}}{\text{Sole crop yield of Mungbean}}$$

Monetary advantages were calculated for each component crop separately as per following formula [10]:

$$\text{Monetary advantage (Tk/ha)} = \text{Value of combined mixed crop yield} \times \frac{(\text{LER} - 1)}{\text{LER}}$$

Where, LER= Land equivalent ratio

Benefit Cost Ratio (BCR) was calculated as follows: $\text{BCR} = \frac{\text{Gross return}}{\text{Cost of production}}$

Data on different yield contributing characters were compiled and appropriate statistical analysis made following the ANOVA technique. The difference among the means were adjudged by Duncan' s New Multiple Range Test (DMRT) as detailed by Gomez and Gomez (1984) [9].

III. Results and Discussion

Effect on the growth and yield of off-season jute seed crop

Plant population of jute was significantly affected by the mixed cropping treatments (Table 01). The highest plant population (49.3 m^{-2}) was found in sole jute treatments because the distance of sole jute was higher than mixed cropping treatments. Sole jute gets proper light, air and other growth factors. The plant height of jute was not significantly affected by different mixed cropping treatments at varying seeding ratios (Table 01). The plant height of jute ranged between 90.0 cm to 112.8 cm. The highest plant height (112.8 cm) was noticed in treatment 100% mungbean + 80% jute. The numbers of branches per plant were not significantly affected by mixed cropping treatments. The branches of jute plant were the highest (10.4) in mixed crop treatment (80%mungbean+20%jute) and the branches of jute plant were lowest in 80%mungbean+80%jute treatment. The numbers of pods per plant were not significantly affected by mixed cropping treatments. The highest number (19.4) of pods plant^{-1} was obtained in 80%mungbean+20%jute treatment probably due to maximum number of branches plant^{-1}. The mean values of 1000-seed weight of jute were not significantly affected as shown by different treatments. The highest 1000-seed weight (2.93 g) was found in 100% mungbean + 60% jute treatment and the lowest 100-seed weight (2.20 g) was found in 80% mungbean + 80% jute treatment. Seed of jute plant was significantly affected by different treatments (Table 01). The highest seed yield (485.5 kg ha^{-1}) of jute was obtained from the sole jute treatments which was the highest from the seed yield of all other mixed cropped treatments. The jute seed yield was reduced due to mixed cropping.

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Table 01. Effect of mixed cropping on the growth and yield of off-season jute seed crop with mungbean

Treatments	Plant Population per sq-m	Plant height (cm)	Branches Plant^{-1} (No.)	Pods plant^{-1} (No.)	1000-seed weight (g)	Seed yield m^{-2} (g)
Sole jute	49.3a	109.5ab	6.0de	14.2bc	2.55d	48.55a
Sole mungbean	-	-	-	-	-	-
100%mungbean+20%jute	24.0fg	88.3d	9.2b	7.8gh	2.48de	17.5i
100%mungbean+40%jute	32.0e	105.7b	9.13b	10.4ef	2.72bc	27.0e
100%mungbean+60%jute	38.0cde	107.7ab	8.0c	13.4c	2.93a	40.0c
100%mungbean+80%jute	45.0ab	112.8a	5.4e	14.8b	2.45ef	45.0b
80%mungbean+20%jute	20.0fg	104.0b	10.4a	19.4a	2.74b	12.25j
80%mungbean+40%jute	26.0f	104.4b	9.2b	10.6e	2.52de	16.9i
80%mungbean+60%jute	34.0de	104.7b	6.0de	8.2g	2.65c	19.0hi
80%mungbean+80%jute	44.0abc	106.4ab	4.6f	6.8h	2.20h	35.0d
60%mungbean+20%jute	18.0g	92.0cd	8.4c	5.0i	2.35g	25.0ef
60%mungbean+40%jute	25.0f	104.0b	6.6d	9.4f	2.68bc	20.8gh
60%mungbean+60%jute	40.0bcd	97.0c	6.4d	10.6e	2.38fg	22.45fg
60%mungbean+80%jute	44.0abc	90.0d	6.2d	11.8d	2.70bc	26.0e
CV(%)	*10.24*	*3.53*	*4.82*	*5.55*	*1.61*	*6.58*
Lsd value	*5.831*	*6.069*	*0.5982*	*1.025*	*0.07536*	*3.033*
Level of significance	**	0.00**	0.00**	0.00**	0.00**	0.00**

*Significant at 5% level ** Significant at 1% level; Same letter(s) in a column do not differ significantly at P ≤.05

Yield of component crop

Yields of mungbean were decreased due to mixed cropping (Table 02). The highest yield (1052 kg/ha) was obtained from sole mungbean. Seed yield of mungbean was reduced in mixed cropping. This difference was due to competition of light, nutrition, air in mixed crops which reduced the number of seeds per plant. The result revealed that sole crop gave the highest yield, mixed cropping reduced components crops yield in comparison to their sole cropping. But jute sole crop yield was not reduced considerably compared to mix cropping. The LER values of mixed cropping ranges from 0.688 to 1.16 (Table 03). Moreover, the results indicated that mixed cropping may increase total crop productivity per unit area which was found similar to Haque *et al*. (1978) [11].

Productivity of mixed cropping

Total land productivity is a basic consideration in evaluation of mixed cropping system where land holding are very insufficient. For this purpose, yield requirement, land equivalent ratio (LER), relative yield and monetary advantage per hectare could be better indicators of relative advantages of different mixed cropping practices [2]. The productivity parameters were computed and presented in Table 03.

Jute seed equivalent yield: Higher jute seed equivalent yield were obtained from most of the mixed cropping treatments than that of the seed yield recorded in sole crop of jute treatment. The jute seed equivalent yield was highest in 100%mungbean+80%jute treatment (Table 03). The lower jute seed equivalent yield was found in 60%mungbean+80jute treatment.

Land equivalent ratio: The land equivalent ratio (LER) values were found more than 1(one) in case of some of the mixed cropping treatments (Table 03). It indicates the yield advantages in mixed cropping compared to sole cropping. The highest LER (1.16) was obtained in 100%mungbean+ 80%jute treatment followed by the treatment of 60%mungbean + 20%jute (1.11). The LER of 1.16 means that by mixed cropping the present experiment was produced 250kg of mungbean and 450kg of jute seed from one hectare of land instead of growing it separately in 1.16 hectares of land (Table 03) which was found similar to the findings of BJRI (1986) [6].

Table 02. Yield and by-product yield of off-season jute seed crop and mungbean as affected by mixed cropping system

Treatments	Yield of crops (kg ha^{-1})		By-product (kg ha^{-1})	
	Jute seed	Yield of component crop	Jute	Component crop
Sole jute	485.5a	-	3500a	
Sole mungbean	-	1052a	-	2750b
100%mungbean+20%jute	175i	550d	3000b	1750f
100%mungbean+40%jute	270e	200h	3000b	2000e
100%mungbean+60%jute	400c	250g	2500c	2500c
100%mungbean+80%jute	450b	250g	2000d	2750b
80%mungbean+20%jute	122.5j	680b	3000b	2000e
80%mungbean+40%jute	169i	460e	2500c	2200d
80%mungbean+60%jute	190hi	388f	2500c	2500c
80%mungbean+80%jute	350d	400f	2000d	3000a
60%mungbean+20%jute	250ef	635c	3000b	1500g
60%mungbean+40%jute	208gh	290g	3000b	2000e
60%mungbean+60%jute	224.5fg	282g	2500c	2500c
60%mungbean+80%jute	260e	161h	2000d	2750b
Cv%	*6.58*	*5.79*	*7.25*	*2.46*
LSD value	*3.033*	*4.199*	*32.42*	*9.635*
Level of significance	0.00**	0.00**	0.00**	0.00**

*Significant at 5% level; ** Significant at 1% level; Same letter(s) in a column do not differ significantly at P ≤.05

Monetary advantage: Monetary advantage provides an appropriate economic assessment of mixed cropping in terms of increased value per unit area of land.. The highest monetary advantage was estimated from the treatment of 100%mungbean+80%jute (Tk. 11724.13/ha) followed by the treatment of 60%mungbean+20%jute (Tk. 8121.17/ha) (Table 03) The higher monetary advantage in mixed cropping might be due to higher yield and market price of jute. These findings are in conformity with the findings of Islam *et al.* (1992) [12].

Table 03. Jute seed equivalent yield, land equivalent ratio (LER) and monetary advantage of different mixed cropping versus sole cropping

Treatments	Jute seed equivalent yield (kg ha^{-1})	Land Equivalent Ratio (LER)	Monetary advantage (Tk ha^{-1})
Sole jute	485.5cd	1.00c	0000.00d
Sole mungbean	1052a	1.00c	0000.00d
100% mungbean +20%jute	431.66de	0.883d	-8579.55e
100% mungbean +40%jute	363.33f	0.746ef	-18556.30g
100% mungbean +60%jute	516bc	1.06bc	4386.79c
100% mungbean +80%jute	566.66b	1.16a	11724.13a
80% mungbean +20%jute	439.83d	0.898d	-7493.81e
80% mungbean +40%jute	383ef	0.785e	-15762.10f
80% mungbean +60%jute	371.06f	0.760ef	-17576.84g
80% mungbean +80%jute	536.66bc	1.10ab	7318.18b
60% mungbean +20%jute	546.33b	1.11ab	8121.17b
60% mungbean +40%jute	343.33f	0.704ef	-21653.40i
60% mungbean +60%jute	356.1f	0.730ef	-19756.23h
60% mungbean +80%jute	335.13f	0.688f	-22796.86i
Cv%	*6.56*	*4.31*	*6.87*
LSD value	*52.91*	*0.07506*	*1359*
Level of significance	**	**	**

*Significant at 5% level; ** Significant at 1% level; Same letter(s) in a column do not differ significantly at P ≤.05
Selling price of each crop per kg were jute seed Tk. 150 and mungbean Tk. 70 and that of by-products were jute and mungbean dry plant Tk. 2 at local market basis.

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Relative yield

The relative yield of jute seed crop was decreased in mixed cropping with mungbean in comparison to sole jute treatment (Table 04). It is due to the higher competition of moisture, space, light and nutrients with each other. The results of this reduction of relative yield in mixed cropping are in conformity with the findings of Rahman and Shamsuddin (1981) [14].

Table 04. Yield and relative yield of different mixed cropping versus sole cropping treatments

Treatments	Jute seed yield (kg ha^{-1})	Jute seed relative yield	Mungbean yield(kg ha^{-1})	Mungbean relative yield
Sole jute	485.5	1.00a	-	-
Sole mungbean	-	-	1052	1.00a
100% mungbean +20%jute	175	0.360i	550	0.522c
100% mungbean +40%jute	270	0.556e	200	0.19gh
100% mungbean +60%jute	400	0.823c	250	0.237fg
100% mungbean +80%jute	450	0.92b	250	0.237fg
80% mungbean +20%jute	122.5	0.252j	680	0.646b
80% mungbean +40%jute	169	0.348i	460	0.437d
80% mungbean +60%jute	190	0.391hi	388	0.368e
80% mungbean +80%jute	350	0.720d	400	0.380e
60% mungbean +20%jute	250	0.514ef	635	0.603b
60% mungbean +40%jute	208	0.428gh	290	0.275f
60% mungbean +60%jute	224.5	0.462fg	282	0.268f
60% mungbean +80%jute	260	0.535e	161	0.152h
CV%	-	*6.84*	-	*8.53*
LSD value	-	*0.053*	-	*0.053*
Level of significance	-	**	-	**

*Significant at 5% level; ** Significant at 1% level; Same letter(s) in a column do not differ significantly at P≤.05

Cost and return analysis

Gross return: The highest gross return was obtained from the treatment of 100%mungbean+80%jute (Tk. 94500 ha^{-1}) followed by treatment of 60%mungbean+20%jute (Tk. 90950 ha^{-1}) (Table 05). The treatment of 60%mungbean+80%jute gave the lowest gross return of Tk. 59770/ha^{-1}).

Total variable cost: The highest variable cost was observed at 100%mungbean + 80%jute treatment (Tk. 70698 ha^{-1}) followed by 100%mungbean+60%jute treatment (Tk. 70509 ha^{-1}). Variable cost of sole jute was higher than that of sole mungbean because jute requires more fertilizer and more number of labour for intercultural operation (Table 05). Cost of production (Total variable cost) was calculated by taking the price of each kg of commodities of jute seed Tk. 150, mungbean seed Tk. 70, urea Tk. 12, TSP Tk. 40, MP Tk. 30. Gypsum Tk. 3 respectively on the basis of government and local market price. Labour 100Tk/day, Bank interest 13% per year.

Net return: The highest net return over variable cost was obtained from sole mungbean treatment (Tk. 26323.5/ha) than that of 100%mungbean+80%jute treatment (Tk. 23802/ha). The lowest net return over variable cost was obtained (-9605) from 60%mungbean+80%jute Treatment.

Benefit cost ratio: The highest benefit cost ratio (1.49) was obtained from sole mungbean treatment followed by 100%mungbean+80%jute (1.34) and 60%mungbean+20%jute treatment (1.32), respectively (Table 05). The highest benefit cost ratio in sole mungbean due to its high yield and low cost of production compared to other component crops.

Table 05. Cost and return analysis of different treatments

Treatments	Yield (kg ha^{-1})				Gross return (Tk ha^{-1})	variable cost of cultivation (Tk ha^{-1})	Net return (Tk ha^{-1})	Benefit cost ratio
	Product		By-product					
	Main crop	Component crop	Main crop	Component crop				
T1	485.5	-	3500	-	79825	60660	19165	1.31
T2	1052	-	-	2750	79140	52816.5	26323.5	1.49
T3	175	550	3000	1750	74250	70131	4119	1.05
T4	270	200	3000	2000	64500	70320	-5820	0.91
T5	400	250	2500	2500	87500	70509	16991	1.24
T6	450	250	2000	2750	94500	70698	23802	1.34
T7	122.5	680	3000	2000	75975	69469.5	6505.5	1.09
T8	169	460	2500	2200	66950	69658.5	-2708.5	0.96
T9	190	388	2500	2500	65660	69847.5	-4187.5	0.94
T10	350	400	2000	3000	90500	70036.5	20463.5	1.29
T11	250	635	3000	1500	90950	68808	22142	1.32
T12	208	290	3000	2000	61500	68997	-7497	0.89
T13	224.5	282	2500	2500	63415	69186	-5771	0.91
T14	260	161	2000	2750	59770	69375	-9605	0.86

Note: Gross return was calculated by taking the selling price at local market basis of each kg of commodity as jute seed Tk. 150 and mungbean Tk. 70 and that of each kg by-product of dry jute and mungbean plant Tk. 2 Respectively.

IV. Conclusion

Mixed cropping of mungbean and jute seed crop can be practiced successfully with higher productivity and better economic returns as compared to the sole cropping of jute. Although sole mungbean are beneficial but by mixed cropping both jute seed and mungbean can be obtained in the same time from the same piece of land. These findings, however, need to be further studied and evaluated in different agro-climatic regions before final recommendation as a technology to be adopted by the farmers.

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APA (American Psychological Association)

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