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Improvement of production and net economic return through intercropping of upland cotton with mungbean

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ABSTRACT

Bangladesh has a glorious historic record in growing superfine quality cotton. The performance of mungbean inter-cropped in upland cotton cultivars was evaluated in the field of Cotton Research, Training and Seed Multiplication Farm, Sadarpur, Dinajpur 2011-2012 to find out the ways of improvement of production and net economic return through intercropping of upland cotton with mungbean. The treatments were; T_1-Cotton cv Rupali 1/Mungbean cv BARI Mung-6, T_2 -Cotton cv DM 1/Mungbean cv BARI Mung-6, T_3 -Cotton cv CB 12/Mungbean cv BARI Mung-6, T_4- Cotton cv CB 10-Mungbean cv BARI Mung-6, T_5 -Cotton cv Rupali 1 (Sole), T_6 -DM 1 (Sole), T_7 -CB 12 (Sole), T_8 -CB 10 (Sole) and T_9 -Sole mungbean. The seed cotton yields did not respond significantly among the treatments of cotton-mungbean intercropping systems and sole cotton as well. The highest grain yield of mungbean (702 kg ha^{-1}) was obtained from the sole mungbean than the other treatments because of the highest mungbean plant density. Mungbean intercropping with cotton produced the highest seed cotton equivalent yield, gross margin and gross return for local varieties as well as hybrid lines. The lowest gross return, gross margin and Benefit cost ratio (BCR) were obtained from the treatment of sole mungbean. Mungbean based intercropping in cotton would be ideal for increasing productivity and profitable benefit returns per unit land area, which ultimately encourage farmers for sustainable cotton cultivation in Bangladesh.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is known as white gold and queen of fibres that plays a significance role in world agriculture and industrial economy (Daisy et al. 2017). It is one of the most important textile fibers in the world, accounting for around 35% of total world fiber use (Singh 2014). The annual requirement of cotton in our country is 4.2 million bales in 2011 which is very higher as compared production area as well as cotton production (Adams et al. 2011). Cotton yield was progressively influenced by the proper vegetative and reproductive growth resulting higher yield of seed cotton (Niakan and Habibi 2013). Cotton cultivated more than 80 countries of the world represents 2.5% of all cultivated land but among these, 10 countries-China, U.S.A, Russia, India, Brazil, Pakistan, Turkey, Egypt, Mexico and Sudan are accounted for 85-90% of the total production. In the past 'Muslin' was popular and famous throughout the world (Baten 2014).

At present, more than 152 yarn and textile mills are running in Bangladesh. Though 0.6 to 0.7 million bales of medium and long staple cotton fiber are used in these mills annually (Anon. 2001; Rasel 2007). The total cotton production in Bangladesh is around 40-42 lac bale (1 bale=182 kg or 400 pounds) that can meet only 3-5% of our national demand (Baten 2014). The rest of the requirement is imported from abroad at the expense of costly foreign currency. Therefore, there is a great scope to increase the cotton production in Bangladesh.

Upland cotton is being cultivated commercially in Bangladesh. It has potential benefit as a cash crop. Cotton is profitable as a sole crop however; it would be more profitable by introducing mungbean intercropping in cotton cultivation, as well as N_2 fixation is an additional advantage of improving soil health in addition to pulse yield. In this context, only few findings

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available on cotton based cropping patterns to fit cotton in local cropping patterns or to develop cotton based cropping patterns (Mian and Mandol 2004a, Amin 2008a). Intercropping provides the best utilization of land and time (Mian and Mandol 2004b). National and international studies supported that more benefit can be achieved introducing cotton intercropping. Beneficial effects of intercropping lentil with sweet potato were cited by Basak and Khurram (2001), cotton with mungbean by Rahman et al. (1993 and 1994), wheat with coriander and linseed by Hossain et al. (1990), maize with chickpea by Khaleque et al. (1990), and maize with rice by Quayyum and Jahiruddin (1985). Mungbean (*Vigna radiata*) could be appropriately fitted in cotton + mungbean intercropping system due to its short life cycle (Tabib et al. 2014). The main reason of including legume in intercrops are due to their ability to reduce soil erosion, improving land productivity through soil amelioration, suppress weeds and fix nitrogen (Daisy et al. 2017). Cotton provides ample scope for raising intercrops due to slow growing nature during the initial stage of crop growth (Kumar et al. 2017). Intercropping of cotton with pulses could be a promising strategy for increasing in the productivity of cotton, edible oilseeds and fodders to fulfill the diversified needs of growing population (Daisy and Rajendran 2017).

However, few works on intercropping mungbean with cotton have been reported. Mungbean is an important pulse crop and it has great demand in Bangladesh. Modern mungbean varieties in Bangladesh like BARI Mung-5, BINA Mung-6 etc. could be grown with cotton as intercrop as it cultivated whole crop season such as Kharif-I, Kharif-II and Rabi seasons.

Cropping systems and cropping patterns in Bangladesh are rich in diverse crop varieties and are adjusted to occurrence and availability of natural resources (Sultana 2008). For example, it has been noted that the annual productivity of the rice-wheat intercropping systems in Bangladesh is declining. Hence, integrated efforts in future research programs on the development of triple cropping patterns to improve or sustain the productivity of the systems would be needed. Growing dual or triple purpose crops and developing appropriate mixed, intercropping, and relay cropping systems, development of integrated nutrient (organic, green manure and inorganic) management practices for sustainable system productivity, long term monitoring of fertilizer use and soil fertility for the system would be promising attempts (Elahi et al. 1995). Though cotton is one of the most important commercial crops in the world, it is not popular in Bangladesh shadowed by the top priority given for food crops to meet the ever increasing demand of food. Many studies have been done on cotton as a sole or mono crop, but there is lack of information on cotton based intercropping or cropping patterns and its economic impacts (Amin 2008b).

Details of diverse aspects of intercropping in cotton at different patterns of cotton cultivation need to be explored in order to make the cotton-based intercropping system more viable and economical. Therefore, this research work is aimed at intercropping of cotton with mungbean for better productivity and efficient utilization of land, and to test cotton-mungbean intercropping for sustainable cotton cultivation.

MATERIALS AND METHODS

Experimental site, soil and climatic condition

An experiment was done on mungbean intercropping with cotton at Cotton Research, Training and Seed Multiplication Farm, Cotton Development Board, Sadarpur, Dinajpur, Bangladesh during the growing season (July to March) of 2011-12. The experimental field is located at $25^{0}42'$ N latitude and $88^{o}35'$ E longitude at a height of 35.5 m above the mean sea level and lies in the Agro-Ecological Zone 1, Old Himalayan Piedmont plain (AEZ 1) in Bangladesh (BARC 1997). The experimental site is located in flood free high land area having soil pH 5.3 to 6.1. The texture of both surface (0-15 cm) and sub-surface soil is sandy-loam with low organic matter and total N contents (Table 1). The fertility problems include rapid leaching of N, K, S, Ca, Mg and B (BARC 1997).

The experimental field is situated under Sub-tropical climate where the rainfall is heavy during Kharif season (April to September) and scanty in Rabi season (October to March). In Rabi season, temperature is generally low and there is plenty of sunshine. The temperature tends to increase from February as the season proceeds towards Kharif.

Planting material, land preparation and crop establishment

The certified seeds of cotton and mungbean were collected from the Cotton Research, Training and Seed Multiplication Farm, Cotton Development Board, Sadarpur, Dinajpur, Jagodishpur, Jessore and local market, Bangladesh and Pulse Research Center (BARI) Ishurdi, Pabna, Bangladesh, respectively. The tested cotton and mungbean varieties were used CB 10, CB 12, Rupali 1, DM 1, and BARI Mung-6, respectively.

The experimental land was prepared by disc harrowing followed by mixing sun hemp residues with soil during harrowing. Ploughing was followed by laddering in order to break clods and to level the land. Weeds were removed from the experimental field.

Table 1. Soil morphological, physical and chemical characteristics of the experimental field

Morphological characteristics				
AEZ	Old Himalayan Piedmont plain (AEZ 1)			
General Soil Type	Non-calcareous Brown Floodplain Soils			
Parent material	Piedmont alluvium			
Drainage	Moderately well drained			
Topography	High land			
Flood level	Above flood level			
Physical characteristics				
	Surface soil (0-15 cm)		Sub-Surface soil (15-30 cm)	
Sand (%)	58		55	
Silt (%)	32		32	
Clay (%)	10		13	
Textural class	Sandy loam		Sandy loam	
Chemical characteristics				
	Surface soil (0-15 cm)		Sub-Surface soil (15-30 cm)	
	Content	**Interpretation***	**Content**	**Interpretation***
pH (soil : water=1:2.5)	6.12	Acidic	5.24	Acidic
Organic matter (%)	1.38	Very low	1.03	Very low
Total N (%)	0.08	Low	0.06	Very low
CEC (meq 100 g^{-1})	4.8	-	4.0	-
Available P (µg g^{-1})	83.40	Very high	77.29	Very high
Available K (meq 100 g^{-1})	0.17	Medium	0.13	Medium
Available Ca (meq 100 g^{-1})	2.0	Low	1.1	Very low
Available Mg (meq100 g^{-1})	0.60	Low	0.25	Very low
Available S (µg g^{-1})	11.47	Low	8.21	Low
Available Na (meq 100 g^{-1})	0.13	-	0.11	-
Available B (µg g^{-1})	0.31	Medium	0.17	Low
Available Cu (µg g^{-1})	1.03	Very high	1.15	Very high
Available Fe (µg g^{-1})	23.3	Very high	24.2	Very high
Available Zn (µg g^{-1})	2.23	Very high	2.41	Very high
Available Mn (µg g^{-1})	32	High	2.4	Optimum

***BARC, 1997**

Experimental design and treatments

The experiment was laid out in randomize complete block design (RCBD) with four replications where all together 36 (9 × 4) unit plots with the size of 4.5 m X 3.6 m each. Outside border, inter-replication and inter-plot spacing were 2 m, 1.8 m and 1.5 m, respectively. The treatments imposed were: T_1= Rupali 1-mungbean, T_2= DM 1-mungbean, T_3= CB 12-mungbean, T_4= CB 10-mungbean, T_5= Rupali 1 (sole), T_6= DM 1 (sole), T_7= CB 12 (sole), T_8= CB 10 (sole) and T_9= Sole mungbean.

Fertilizer application

For cotton, the fertilizers were applied at the rate of 138 kg N, 37 kg P, 75 kg K, 20 kg S, 5 kg Zn, 2 kg B, and 2 kg Mg in the form of Urea, TSP, MP, Gypsum, Zinc sulphate, Borax and Magnesium sulphate, respectively and 5000 kg cow-dung per hectare. All fertilizers except micronutrients were applied, as four equal splits as basal, 30, 54 and 76 days after sowing. Micronutrients i.e., Zn, B and Mg were applied as 54 days after sowing. Cow-dung was applied at 30 days after sowing. All fertilizers for both basal and topdressing were applied in furrows in the both side of cotton rows.

For mungbean, the fertilizers were applied at the rate of 23 kg N, 17 kg P and 17.5 kg K per hectare in the form of urea, TSP and MP, respectively. All fertilizers were applied as basal.

Sowing of seeds

Both cotton and mungbean seeds were sown at the rate of 15 kg seed ha^{-1} and 30 kg ha^{-1}, respectively in a north-south row alignment on 26 July, 2011. The seeds were sown by keeping the distance of 45 cm between plants and 90 cm between rows for cotton. Mungbean seeds were sown continuously by keeping 90 cm row distance in the treatment of T_1, T_2, T_3, T_4 and 30 cm was in the treatment of sole mungbean T_9. The line of mungbean was adjusted in between the two rows of cotton in the treatment of T_1, T_2, T_3 and T_4. All seeds were sown at the depth of 2 to 3 cm from the surface soil and covered manually with loose soils.

Intercultural operations

Two irrigations were applied for cotton, first irrigation 88 days after sowing, second after 123 days after sowing. No irrigations were applied for mungbean. Three weedings were done during the whole growing period of cotton at 24, 46 and 63 days after sowing accordingly. Mungbean received first and second weeding combine with cotton as intercropping. Integrated pest managements such as all chemical and mechanical control measures were applied specially for cotton. Five sprays were applied when the pest levels exceeded the relevant threshold at regular weekly counts. The insecticides, which are recommended for the use of cotton were used to suppress the pest below economic threshold level (ETL). The systemic insecticides were used for sucking and contact insecticides for chewing pests.

Harvesting and data collection

Cotton, the seed cotton was harvested three times at the maturity stage during December 2011 to February 2012. Plot yields of seed cotton were taken from the inner rows of the plots excluding the border rows of all directions. The sampling area for seed cotton yields was 6.48 square meter. Seed cotton from each unit plots were sun dried and weighed carefully. The results were expressed as t ha^{-1}. For other agronomic data collection, five plants from each plot were sampled randomly. Five plants were selected and then the number of plants per square meter, number of monopodial branches, number of sympodial branches, number of infected bolls and number of effective bolls $plant^{-1}$ were recorded and averaged. Ten bolls $plot^{-1}$ were

Table 2. Price of materials and products at Dinajpur market

SL. No	Items	Units	Price Taka $unit^{-1}$
	Materials/Year		April, 2012
1	Seeds		
	i) Cotton	Kg	15.00
	ii) Mungbean	Kg	75.00
2	Fertilizers		
	i) Urea	Kg	20.00
	ii) TSP	Kg	42.00
	iii) MP	Kg	36.00
	iv) Gypsum	Kg	8.00
	v) Zinc sulphate	Kg	150.00
	vi) Mg sulphate	Kg	65.00
	vii) Borax	Kg	150.00
	viii) Cowdung	Kg	1.00
3	Insecticides		
	i) Asataf 75SP	Kg	1053.00
	ii) Admire 200SL	Litre	-
	iii) Imitaf 20SL	Litre	2710.00
	iv) Dursban 20EC	Litre	750.00
	v) Chloropyriphos 20EC	Litre	750.00
	vi) Actara 25WG	Kg	25000.00
	vii) Marshal 20EC	Litre	750.00
	viii) Ripcord	Litre	850.00
	ix) Desis	Litre	1097.00
	x) Symbush	Litre	600.00
	xi) Sobichron	Litre	1050.00
4	Fungicide		
	i) Indofil	Kg	536.00
5	Labour	Monday	180.00
6	Products		
	i) Seed cotton	Kg	70.00/60.00 (CB 10)
	ii) Mungbean	Kg	70.00

selected, dried and then weighed carefully. The weight of bolls were recorded and averaged. The results were expressed as g boll^{-1}. All economic data were taken for cost benefit analysis.

Mungbean, The mungbean pods were harvested two times dated on 17 and 26 September 2011. The samples were sun dried and then weighed carefully after harvested from 16.2 square meter area for calculating grain yield. The results were expressed as kg ha^{-1} at 12% moisture level. Randomly selected five plants from each plot were sampled for recording yield parameters. All economic data were taken for cost benefit analysis.

Economic analysis

Partial budget, It was estimated on gross margin (net return) considering the factors that changed with varying levels of inputs in each treatment combination. Variable cost and gross margin were calculated as described by Teague and Shulstad (1981). In order to conduct partial budgeting, the prevailing market prices of Dinajpur market were considered. In case of labor, it was equal in all treatments for seed sowing, intercultural operations such as weeding, irrigation, chemical control measures and post-harvest practices i.e. harvesting, threshing, cleaning and drying etc. Cotton equivalent yields were calculated by conversion the yields of mungbean into the yields of cotton on the basis of market price of individual crops. The price of materials and products were based on local market prices (Table 2).

Statistical analysis

The data were analyzed statistically (Gomez and Gomez 1984) by F-test to examine whether the treatment effects were significant. The mean comparisons of the treatments were evaluated by DMRT (Duncan's Multiple Range Test). The analyses of variance (ANOVA) for different parameters were done by a computer package programme "MSTATC".

RESULTS AND DISCUSSIONS

Cotton

Overall results of our study inferred that there were no significant differences in the parameters of the number of bolls plant^{-1}, boll weight, plant height and number of sympodial branches among the treatments tested. Significantly the lowest number of monopodial branches was found in the treatment of CB 10 with mungbean intercropping compared to all other treatments (Table 3). The seed cotton yields did not respond significantly among the treatments of cotton intercropping as well as sole cotton, which was supported by Mohamed et al. (1999). However, numerically the highest seed cotton yield (2.21 t ha^{-1}) was recorded from the sole cotton CB 10, followed by sole cotton CB 12, while the lowest seed cotton yield (1.81 t ha^{-1}) was found in sole cotton DM 1 (Figure 1). The experiment was suffered from heavy rainfall from sowing to 20 days after sowing.

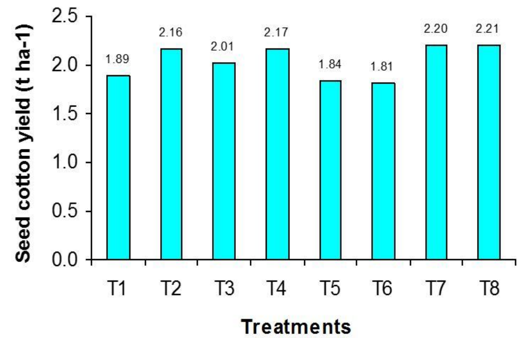

Figure. 1 Seed cotton yield as influenced by intercropping with mungbean during 2011-12

Mungbean

The number of grains per pod, pod length and plant height were not significantly differ in all the treatments (Table 4), while significant differences were detected in the grain yield of mungbean among the treatments. The highest grain yield of mungbean (702 kg ha^{-1}) was obtained from the sole mungbean than other treatments due to cause of higher number of plants per square meter (Figure 2).

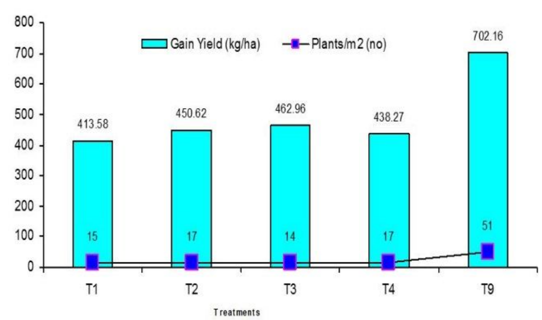

Figure 2. Yield of mungbean as influenced by intercropping with cotton during 2011-12.

Mungbean produced pulses in addition to adding some amount of biomass into the soil through leaf shadding, plant residues and nodulation. Extra output can be harvested from second crop mungbean as intercrops in such double cropping systems.

Equivalent yield

The highest seed cotton equivalent yield (2.61 t ha^{-1}) was obtained from DM 1 intercropping with mungbean, which was followed by CB 10 and CB

Table 3. Yield contributing characters of cotton as influenced by intercropping with mungbean during 2011-12

Treatments	Number of bolls (plant^{-1})	Weight of boll (g boll^{-1})	Number of monopodial branch (plant^{-1})	Number of sympodial branch (plant^{-1})	Plant height (cm)
T_1 Rupali 1-mungbean	17.93	5.95	2.90 a	12.70	110.48 a
T_2 DM 1-mungbean	22.78	5.88	2.40 ab	14.20	92.38 ab
T_3 CB 12-mungbean	21.13	5.55	2.15 ab	13.73	90.25 ab
T_4 CB 10-mungbean	22.38	5.80	1.85 b	13.73	86.80 ab
T_5 Rupali 1(Sole cotton)	20.20	6.13	2.30 ab	13.15	91.15 ab
T_6 DM 1 (Sole cotton)	18.83	5.73	2.10 ab	13.03	83.53 b
T_7 CB 12 (Sole cotton)	21.85	5.85	2.98 a	13.40	90.10 ab
T_8 CB 10 (Sole cotton)	21.78	6.03	2.20 ab	13.75	87.20 ab
T_9 Sole mungbean	-	-	-	-	-
CV %	11.86	6.49	17.28	8.14	7.37
Lsd	NS	NS	*	NS	*

Table 4. Yield contributing characters of mungbean as influenced by intercropping with cotton during 2011-12

Treatments	**Pod length (cm)**	**Number of grains (pod^{-1})**	**Plant height (cm)**	**Number of plants (m^{-2})**
T_1 Rupali 1 - mungbean	10.05	11.75	39.40	15.28 b
T_2 DM 1 - mungbean	10.03	11.70	41.40	17.03 b
T_3 CB 12 - mungbean	10.03	11.55	40.55	14.16 b
T_4 CB 10 - mungbean	9.80	11.80	38.20	16.66 b
T_9 Sole mungbean	9.70	11.00	39.90	51.10 a
CV %	4.13	7.42	8.40	9.80
Lsd	NS	NS	NS	**

12 intercropping with mungbean, and the lowest (0.70 t ha^{-1}) was found in sole mungbean (Table 5).

Cotton varieties Rupali 1, DM 1, CB 12 and CB 10 intercropping with mungbean produced 25, 44, 12 and 15 per cent higher seed cotton equivalent yield than monoculture cotton and 229, 273, 253 and 264 per cent higher than monoculture mungbean, respectively. Similar yield advantages of chilli intercropping with cowpea have been reported by Khaliq et al. (1997). Total production and land use efficiency was always higher where two crops were grown in the cropping patterns compared to sole crops (Table 5). These results are in agreement with those reported by Mao-ShuChun et al. 1998, Soni and Sikarwar 1991, Yang et al. 1989.

As sole cotton keeps the land occupied for 6 months where short duration mungbean intercropping with cotton did not need extra time and land for mungbean cultivation. It was found that mungbean intercropping with cotton did not affect seed cotton yield. Additionally, it has been possible to harvest mungbean as a bonus crop by intercropping with cotton. Thus this sort of intercropping would be useful for increasing total farm productivity.

Production economics

The highest total gross return (1,82,700 tk ha^{-1}) was obtained from the treatment of DM 1 with mungbean intercropping, which was followed by CB 12 with mungbean intercropping, and the lowest total gross return (49,000 tk ha^{-1}) was observed from sole mungbean. Cotton cv Rupali 1, DM 1, CB 12 and CB 10 intercropped with mungbean produced 25, 44, 12 and 15 per cent higher total gross return than monoculture cotton, and 229, 273, 253 and 212 per cent higher than monoculture mungbean, respectively (Table 5).

The highest total gross margin (95,520 tk ha^{-1}) was obtained from the treatment of DM 1 with mungbean intercropping, which was followed by CB 12 with mungbean intercropping (85,720 tk ha^{-1}) and sole cotton CB 12 (85,350 tk ha^{-1}) and the lowest total gross margin (19,920 tk ha^{-1}) was observed from the sole mungbean. Cotton cv Rupali 1, DM 1, CB 12 and CB 10 intercropping with mungbean produced 23, 65, 0.43 and 3 per cent higher total gross margin than monoculture cotton, and 271, 380, 330 and 230 per cent higher than monoculture mungbean, respectively (Table 5).

Benefit cost ratio (BCR) was higher (2.24) in the sole cotton CB 12 followed by the treatments of DM 1 with mungbean intercropping (2.10) and CB 12 with mungbean intercropping (1.98), respectively, and the lowest BCR (1.69) was recorded from the treatment of sole mungbean (Table 5).

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Table 5. Equivalents yield, cost and return analysis of cotton and mungbean intercropping during 2011/12

Treatments / Characters	Yield (t ha^{-1})	Seed cotton equivalent yield (t ha^{-1})	Gross return (tk ha^{-1})	Total variable cost (tk ha^{-1})	Gross Margin (tk ha^{-1})	BCR
T_1 Rupali 1-mungbean (1 row mungbean in between 2 rows of cotton)						
Seed cotton	1.89	1.89	1,32,300	68,650	63,650	1.93
Mungbean	0.41	0.41	28,700	18,530*	10,170	1.55
Total		2.30	1,61,000	87,180	73,820	1.85
T_2 DM 1-mungbean (1 rows mungbean in between 2 rows of cotton)						
Seed cotton	2.16	2.16	1,51,200	68,650	82,550	2.20
Mungbean	0.45	0.45	31,500	18,530*	12,970	1.70
Total		2.61	1,82,700	87,180	95,520	2.10
T_3 CB 12-mungbean (1 rows mungbean in between 2 rows of cotton)						
Seed cotton	2.01	2.01	1,40,700	68,650	72,050	2.05
Mungbean	0.46	0.46	32,200	18,530*	13,670	1.74
Total		2.47	1,72,900	87,180	85,720	1.98
T_4 CB 10-mungbean (1 rows mungbean in between 2 rows of cotton)						
Seed cotton	2.17	2.17	1,30,200	68,650	61,550	1.90
Mungbean	0.44	0.38	22,800	18,530*	4,270	1.23
Total		2.55	1,53,000	87,180	65,820	1.75
T_5 Rupali 1 (Sole cotton)						
Seed cotton	1.84	1.84	1,28,800	68,650	60,150	1.88
Total		1.84	1,28,800	68,650	60,150	1.88
T_6 DM 1 (Sole cotton)						
Seed cotton	1.81	1.81	1,26,700	68,650	58,050	1.85
Total		1.81	1,26,700	68,650	58,050	1.85
T_7 CB 12 (Sole cotton)						
Seed cotton	2.20	2.20	1,54,000	68,650	85,350	2.24
Total		2.20	1,54,000	68,650	85,350	2.24
T_8 CB 10 (Sole cotton)						
Seed cotton	2.21	2.21	1,32,600	68,650	63,950	1.93
Total		2.21	1,32,600	68,650	63,950	1.93
T_9 Sole mungbean						
Mungbean	0.70	0.70	49,000	29,080*	19,920	1.69
Total		0.70	49,000	29,080	19,920	1.69

* Ploughing and weeding cost was considered for sole mungbean for compute the total variable cost, but for mungbean intercropping it was avoided the above mentioned cost; the cost was calculated for cotton.

CONCLUSIONS

Mungbean intercropping with cotton produced higher seed cotton equivalent yield, gross margin and gross return. Mungbean should be intercropped with cotton for increasing productivity and profitable benefit returns, which ultimately would encourage farmers for sustainable cotton cultivation in Bangladesh. The combination of single line mungbean intercropping with cotton appears to be promising in terms of higher yield, and production economics for local varieties as well as hybrid lines except bushy varieties.

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