SAARC J. Agri., 12(1), 09-19(2014)

INTERCROPPING *AUS* RICE WITH DIFFERENT SEED RATES OF BLACKGRAM AS FODDER

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ABSTRACT

A field experiment was conducted to explore the feasibility of blackgram fodder production in *Aus* rice as intercropping system at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from March to July 2009. The experiment was laid out in a randomized complete block design with three replications. The fodder crop was sown at various densities as sole crop for comparison. Growth parameters, yield components and yields were higher in sole cropping. Economic analysis reveals that intercropping systems showed better performance in terms of gross, net return and benefit cost ratio compared to sole cropping of main or fodder crop at various plant populations per unit area. Intercropping blackgram as fodder with 50 kg seed ha^{-1} in *Aus* rice row sowing of 25 cm would be the promising fodder production with minimum grain yield loss of rice with higher profit.

Keywords: Blackgram fodder, *Aus* rice, Intercrop, Yield.

INTRODUCTION

Bangladesh is a densely populated country. In Bangladesh, only 9.09 million hectare land is available to feed 146.70 million people (AIS, 2012). The average availability of meat and milk in Bangladesh is very meagre compared to other parts of the world. Malnutrition is a major problem in the country. Eighty eight percent of the population suffers from protein deficiency (Kabir et al., 2005). Malnutrition may be minimized to a large extent by means of making meat and milk available because meat is a rich source of protein and milk supplies minerals, food energy also protein, fat, carbohydrate and vitamins. Livestock is important assets to the farmers as well as to the national economy in addition to their contribution to the nation's food supply. The role of livestock in cultivation, providing manure for crop production and fuel for cooking, rural transportation and threshing makes economic importance for Bangladesh agriculture. Animal droppings may play an important role to improve soil fertility because in Bangladesh soil fertility is deteriorating day by day due to intensive crop cultivation, introduction of high yielding crop varieties, use of less amount of organic matter and improper soil and crop management practices (Hossain et al.,1995). But in the country there is neither any planned program of fodder production nor the farmers are able to set aside a part of their land solely for fodder production. There is high pressure on land for

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Received: 10.02.2013

production of food for human being. Consequently there is a huge deficit of feed and fodder in the country and the situation is getting worse day by day. To alleviate the situation and to improve the declining livestock productivity it is indispensable to increase fodder production.

Growing fodder as inter or mixed crop with main crop may be effective method of fodder production in Bangladesh. The diversity in the existing inter-and mixed cropping practiced in the tropics has been documented by Beets (1982). Intercropping is a simple and expensive strategy and has been recognized as a potentially benefited technology to increase crop production due to its substantial yield advantage than sole cropping (Awal et al., 2006). Singh et al. (1992) observed that when rice was intercropped with blackgram (*Vigna mungo*) in 2:1 or 3:1 row ratios; the grain yield of rice was 2.28 t ha^{-1} as sole crop and 1.51 to 1.88 t ha^{-1} when intercropped. On the other hand, blackgram yielded 0.44 t ha^{-1} when grown alone and 0.16 to 0.71 t ha^{-1} when intercropped. Sarma and Shyam (1992) observed that in summer direct-seeded rice when intercropped with summer pulses, the highest rice equivalent yield (1.97 t ha^{-1}) and the highest net return were obtained at rice + green gram in 2:1 row ratio. Yield of *Aus* rice and mungbean as fodder were decreased in intercropping compared to their sole crops; but intercropping was superior to sole cropping in terms of gross return, net return, land equivalent ratio, rice equivalent yield and benefit-cost ratio (Kader et al., 1999). Midya et al. (2005) found that intercropping reduced the yield of component crops compared to the respective pure stands. However, sowing of blackgram in rice 30 cm apart after one weeding was the most remunerative system for weed smothering and offered the highest rice-equivalent yield (2711 kg ha^{-1}). With minimum grain yield loss and higher monetary benefit, maize fodder was grown successfully as relay cropping at 25 cm × 15 cm spacing in transplant *Aman* rice (Uddin et al., 2012). Some research work was done but blackgram as fodder crop as mearge. So, this research work was undertaken to study the feasibility of blackgram fodder production in *Aus* rice as intercrop without or with minimum loss of main crop.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymemsingh from March to July 2009. The experimental site was the Old Brahmaputra Floodplain having dark grey soils (UNDP and FAO, 1988). The experimental land was medium high in topography having Non-calcareous Dark Grey soil under Agro-ecological zone (AEZ-9) belonging to the Sonatala series (BARC, 1997). The soil status of the experimental plot was characterized by silt loam in texture, slightly acidic, organic matter below 1.50 % and other nutrients content were medium to low (Pramanik, 2006). The climate of the experimental site is wet, humid and sub-tropical. Main characteristics of the climate are heavy monsoon rainfall, short winter and long dry spell in pre-monsoon. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 4.0 m × 2.5 m. The experimental treatments were: *Aus* rice sole sown in 25 cm apart (T_1), Black gram 50 kg seed ha^{-1} (sole) (T_2), *Aus* rice + Black gram 50 kg seed ha^{-1} (T_3), Black gram 55 kg seed ha^{-1} (sole) (T_4), *Aus* rice + Black gram 55 kg seed ha^{-1} (T_5), Black gram 60 kg seed ha^{-1} (sole) (T_6), *Aus* rice + Black gram 60 kg seed ha^{-1} (T_7), Black gram 65 kg seed ha^{-1} (sole) (T_8), *Aus* rice + Black gram 65 kg seed ha^{-1} (T_9), Black gram 70 kg seed ha^{-1} (sole) (T_{10}), *Aus* rice + Black gram 70 kg seed ha^{-1} (T_{11}), Black gram 75 kg seed ha^{-1} (sole) (T_{12}), *Aus* rice + Black gram 75 kg seed ha^{-1} (T_{13}), Black gram 80 kg seed ha^{-1} (sole) (T_{14}) and *Aus* rice + Black gram 80 kg seed ha^{-1} (T_{15}).

A modern rice variety (BR 21) was used as *Aus* rice. Blackgram variety (BARI mash 3) was used as sole and intercrop with *Aus* rice. *Aus* rice seeds were sown as per treatment on 16

March 2009 at the rate of 60 kg ha^{-1}. Seeds of blackgram were sown in the sole and *Aus* rice sown plots on 16 March 2009 with seven seed rate for each plot as per treatment. The fertilizers for *Aus* rice sole crop at the rate 65-10-20-7-2 kg ha^{-1} and intercrop 90-15-25-10-2 kg ha^{-1} of N-P-K-S-Zn, respectively. At final land preparation the experimental plots were fertilized with full dose of P, K, S and ½ of N and rest N at 35 DAS. Fertilizers for intercrop with *Aus* rice were adjusted. The fertilizers for blackgram fodder sole were applied at the rate 20-10-20-7 kg ha^{-1} of N-P-K-S, respectively. Three times weeding were done at 20, 35 and 50 DAS. There was no need for irrigation during the growing period of the crop. At dough stage the crop was attacked by rice bug (*Leptocorisa oratorius*) and it was successfully controlled by spraying Chlorpyriphos (20 liquid) at the rate of 1 ml l^{-1}. There was no significant incidence of diseases during the growing period of the crop and hence no disease control measure was taken. *Aus* paddy was harvested with sickle on 30 June 2009 when 80% paddies turned golden colour and the panicle curvature. Grain and straw yields were recorded and converted to t ha^{-1} as per treatment at 14% moisture content. Blackgram fodder was harvested on 18 May 2009 at pod formation stage and green fodder yield was recorded. Initial weight of the sample plants were recorded treatment and replication-wise. Sample plants were packed in the brown paper envelop separately and dried in an electric oven at 65^0 C for 72 hours to a constant weight. Dry fodder yield was recorded and converted to t ha^{-1}.

Data were recorded on yield contributing characters and yields of main crop and fodder crop. Economic return was calculated on the basis of market price. Analysis of variance (ANOVA) was done with the help of computer package M-STAT. Differences among the treatment means were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

The harvest index (HI) was calculated using the formula:

$$\text{HI (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

The cost of cultivation, gross return and net return ha^{-1} were computed on the basis of prevailing market price of different commodities as follows:

A. Gross return (Tk. ha^{-1})

i) Sole main crop = Value of grain + Value of straw

ii) Sole fodder crop = Value of fodder yield

iii) Intercrops = Value of grain + Value of straw + Value of fodder yield

B. Net return (Tk. ha^{-1}) = Gross return (Tk. ha^{-1}) - Total cost of cultivation (Tk. ha^{-1})

C. Benefit cost ratio = $\frac{\text{Gross return (Tk. ha}^{-1}\text{)}}{\text{Total cost (variable) of cultivation (Tk. ha}^{-1}\text{)}}$ (Pal et al., 1985)

RESULTS AND DISCUSSION

Yield attributes of Aus rice

Number of effective tillers m^{-2}

Number of effective tillers m^{-2} of *Aus* rice was significantly affected by blackgram fodder intercropping at different seed rates (Table 1). The maximum number of effective tillers m^{-2} (282.6) was observed in sole *aus* rice sown in 25 cm apart, which was followed by *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1} (266.1). The lowest number of effective tillers m^{-2} (157.6) was found in row seeded sole *aus* rice (188.1). Among the intercropping systems, the

number of effective tillers m^{-2} showed the best performance (266.1) when blackgram fodder was intercropped at 50 kg seed ha^{-1} in row seeded *aus* rice. Significant variation of *Aus* rice effective tillers m^{-2} could be due to increase seed rate in blackgram as fodder.

Number of grains panicle^{-1}

Number of grains panicle^{-1} of *Aus* rice was significantly affected by blackgram fodder intercropping at different seed rates (Table 1). The maximum number of grains panicle^{-1} (111.70) was observed in sole *aus* rice sown in row 25 cm apart, which was similar to *Aus* rice in row + blackgram fodder at 50, 55, and 60 kg seed ha^{-1}. Similar trend of performance regarding number of grains panicle^{-1} was observed by Mandal et al. (1989). The lowest number of grains panicle^{-1} (86.09) was found in row seeded *aus* rice + blackgram fodder at 80 kg seed rate ha^{-1}, which was at par with row seeded *aus* rice + blackgram fodder at 50 and 55 kg seed ha^{-1}. Among the intercropping systems, the number of grains panicle^{-1} showed the best performance (110.00) when blackgram fodder was intercropped at 55 kg seed ha^{-1} in row seeded *Aus* rice. Variation of *Aus* rice number of grains panicle^{-1} might be due to increase in blackgram fodder seed rate.

Table 1.Yield and yield components of *Aus* rice in *Aus* rice-black gram intercropping system

Treatment	No. of effective tillers m^{-2}	No. of grains panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Aus rice sole sown in 25 cm apart (T_1)	157.6 f	86.09 d	24.03	2.79 a	4.19 a	39.97 a
Aus rice + Black gram 50 kg seed ha^{-1} (T_3)	188.1 e	90.95 cd	24.00	2.67 ab	4.02 ab	39.88 a
Aus rice + Black gram 55 kg seed ha^{-1} (T_5)	203.9 de	93.02 cd	23.75	2.55 b	3.94 a-c	39.16 b
Aus rice + Black gram 60 kg seed ha^{-1} (T_7)	218.5 d	99.87 bc	23.22	2.35 c	3.50 cd	38.02 c
Aus rice + Black gram 65 kg seed ha^{-1} (T_9)	240.1 c	103.20 ab	23.11	2.23 cd	3.65 b-d	37.96 c
Aus rice + Black gram 70 kg seed ha^{-1} (T_{11})	254.0 bc	110.00 a	23.07	2.11 de	3.45 cd	37.89 c
Aus rice + Black gram 75 kg seed ha^{-1} (T_{13})	266.1 ab	109.20 ab	23.01	2.02 e	3.34 d	37.70 d
Aus rice + Black gram 80 kg seed ha^{-1} (T_{15})	282.6 a	111.70 a	23.00	1.97 e	3.26 d	37.66 d
CV (%)	5.37	5.18	4.98	3.20	7.22	0.22

In a column, figures having similar letters or without letter do not differ significantly whereas figures having dissimilar letters differ significantly as per Duncan's Multiple Range Test (DMRT).

Thousand grain weight

Weight of 1000 grains of *Aus* rice was not significantly affected by blackgram fodder intercropping at different seed rates (Table 1), which indicated that blackgram fodder could be grown successfully as intercrop in different seed rates in *Aus* rice without affecting 1000-grain weight. Numerically the highest 1000-grain weight (24.03 g) was observed in sole *Aus* rice in 25 cm apart and the lowest (23.00 g) in *Aus* rice in row + blackgram fodder 80 kg seed ha^{-1}.

Grain yield

Grain yield of *Aus* rice was significantly affected by blackgram fodder intercropping at different seed rates. The highest grain yield (2.79 t ha^{-1}) was observed in sole *Aus* rice in 25 cm apart, which was at par with *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1}. The improvement of yield components viz., number of effective tillers $hill^{-1}$ and m^{-2}, number of grains $panicle^{-1}$ and weight of 1000-grains in these treatments contributed mainly to the improvement of grain yield of *Aus* rice. Increased number of effective tillers m^{-2} might be due to less attack of insect pests, which was similar to the results of Jhansi (2004), who reported that intercropping of cowpea with cereals resulted in the lowest percentage of dead heart and stem borer infestation. The lowest grain yield (1.97 t ha^{-1}) was found in *Aus* rice in row + blackgram fodder at 80 kg seed ha^{-1}, which was at par with *Aus* rice in row + blackgram fodder at 70 and 75 kg seed ha^{-1}. Among the intercropping systems, the grain yield showed the best performance (2.67 t ha^{-1}) when blackgram fodder was intercropped at 50 kg seed ha^{-1} in *Aus* rice sown in rows. Significant variation of *Aus* rice grain yield might be due to increase in blackgram fodder plants population $unit^{-1}$ area.

Straw yield

Straw yield of *Aus* rice was significantly affected by blackgram fodder intercropping at different seed rates (Table 1). Higher straw yield (4.19 t ha^{-1}) was observed in sole *Aus* rice in 25 cm apart, which was at par with *Aus* rice in row + blackgram fodder at 50 and 55 kg seed ha^{-1}. The lowest straw yield (3.26t ha^{-1}) was found in *Aus* rice in row + blackgram fodder at 80 kg seed rate ha^{-1}, which was at par with *Aus* rice in row + blackgram fodder at 60, 65, 70 and 75 kg seed ha^{-1}. Among the intercropping systems, the straw yield showed the best performance (4.02 t ha^{-1}) when blackgram fodder was intercropped at 50 kg seed ha^{-1} in row *aus* rice. Variation of *Aus* rice straw yield might be due to increase in blackgram fodder plants population $unit^{-1}$ area.

Harvest index (%)

Harvest index % of *Aus* rice was significantly affected by blackgram fodder intercropping at different seed rates (Table 1). The highest harvest index (39.97%) was observed in sole *Aus* rice in 25 cm apart, which was at par with *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1}. The grain and straw yields in these treatments contributed mainly to the improvement of harvest index of *Aus* rice. The lowest harvest index (37.66%) was found in *Aus* rice in row + blackgram fodder at 80 kg seed rate ha^{-1}, followed by 75 kg seed ha^{-1}. Among the intercropping systems, the harvest index showed the best performance (39.88 %) when blackgram fodder was intercropped at 50 kg seed ha^{-1} in *Aus* rice row sowing.

Blackgram fodder

Plant height

Plant height of blackgram fodder was significantly affected by seed rate of blackgram in *Aus* rice-blackgram intercropping system and sole cropping (Table 2). The maximum plant height (48.59 cm) was observed in blackgram fodder sole cropping at 50 kg seed ha^{-1}, which was at par with *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1}. The lowest plant height of blackgram (42.10 cm) was found in *Aus* rice in row + blackgram fodder at 80 kg seed ha^{-1} which was at par with blackgram as fodder sole cropping at 80 kg seed ha^{-1}. Among the intercropping systems, plant height of blackgram showed the best performance (48.05 cm) in *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1}. Significant variation of plant height of blackgram fodder might be due to increase in blackgram fodder seed rate and intercropping with *Aus* rice.

Number of branches $plant^{-1}$

Number of branches $plant^{-1}$ of blackgram fodder was significantly affected by treatments (Table 2). The maximum number of branches $plant^{-1}$ (3.47) was observed in blackgram fodder sole cropping at 50 kg seed ha^{-1}, which was at par with *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1} and blackgram fodder sole cropping at 55 kg seed ha^{-1}. The lowest number of branches $plant^{-1}$ of blackgram (2.47) was found in *Aus* rice in row + blackgram fodder at 80 kg seed ha^{-1}, which was at par with blackgram fodder sole cropping at 75 and 80 kg seed ha^{-1} and *Aus* rice in row + blackgram fodder at 75 kg seed ha^{-1}. Among the intercropping systems, number of branches $plant^{-1}$ of blackgram showed the best performance (3.33) in *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1}. Variation of number of branches $plant^{-1}$ of blackgram fodder might be due to increase in blackgram fodder seed rate and intercropping with *Aus* rice.

Number of leaves $plant^{-1}$

Number of leaves $plant^{-1}$ of blackgram fodder was significantly affected by treatments (Table 2). The number of leaves $plant^{-1}$ (10.40) was observed in blackgram fodder sole cropping at 50 kg seed ha^{-1}, which was at par with *Aus* rice in row + blackgram fodder at 50, 55 and 60 kg seed ha^{-1} and blackgram fodder sole cropping at 55, 60 and 65 kg seed ha^{-1}. The lowest number of leaves $plant^{-1}$ of blackgram (8.20) was found in *Aus* rice in row + blackgram fodder at 80 kg seed ha^{-1}, which was at par with blackgram fodder sole cropping at 70, 75 and 80 kg seed ha^{-1} and *Aus* rice in row + blackgram fodder at 70 and 75 kg seed ha^{-1}. Among the intercropping systems, number of leaves $plant^{-1}$ of blackgram showed the best performance (10.33) in *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1}. Variation of number of leaves $plant^{-1}$ of blackgram fodder might be due to increase in blackgram fodder seed rate and intercropping with *Aus* rice.

Plants m^{-2}

Plants m^{-2} of blackgram fodder was significantly affected by seed rate of blackgram in *Aus* rice-blackgram intercropping system and sole cropping (Table 2). The maximum plants m^{-2} (50.33) was observed in blackgram fodder sole cropping at 80 kg seed ha^{-1}, which was similar to blackgram fodder sole cropping at 75 kg seed ha^{-1} and *Aus* rice in row + blackgram at 75 and 80 kg seed ha^{-1}. The lowest plants m^{-2} (37.33) was found in *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1}, which was similar to blackgram fodder sole cropping at 50 and 55 kg seed ha^{-1} and *Aus* rice in row + blackgram fodder at 55 kg seed ha^{-1}. Variation of plants m^{-2}

of blackgram fodder might be due to increase in blackgram fodder seed rate and intercropping with *Aus* rice.

Weight of individual plant

Weight of individual plant of blackgram fodder was significantly affected by seed rate of blackgram in *Aus* rice-blackgram intercropping system and sole cropping (Table 2). The maximum weight of individual plant (47.87 g) was observed in blackgram fodder sole cropping at 50 kg seed ha^{-1}, which was at par with *Aus* rice in row + blackgram fodder at 50 and 55 kg seed ha^{-1} and blackgram fodder sole cropping at 55 and 60 kg seed ha^{-1}. The lowest weight of individual plant of blackgram (33.35 g) was found in *Aus* rice in row + blackgram fodder at 80 kg seed ha^{-1}, which was at par with blackgram fodder sole cropping at 80 kg seed ha^{-1} and *Aus* rice in row + blackgram fodder at 75 kg seed ha^{-1}. Variation of weight of individual plant of blackgram fodder might be due to increase in blackgram seed rate.

Green fodder yield

Green fodder yield of blackgram was significantly by treatment. Higher green fodder yield (17.52 t ha^{-1}) was observed in blackgram fodder sole cropping at 80 kg seed ha^{-1}, which was similar to blackgram sole cropping at 75 kg seed ha^{-1} and *Aus* rice in row + blackgram at 80 kg seed ha^{-1}. The maximum plant population of blackgram in these treatments were mainly responsible for the highest green fodder yield. The lowest green fodder yield (11.98 t ha^{-1}) was found in *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1}, which was similar to blackgram fodder sole cropping at 50 kg seed ha^{-1}. Among the intercropping systems, green fodder yield of blackgram showed the best performance (17.27 t ha^{-1}) in *Aus* rice in 25 cm apart + blackgram at 80 kg seed ha^{-1}. Variation of green fodder yield of blackgram might be due to increase seed rate in blackgram.

Table 2. Plant characters and yield of black gram fodder in *Aus* rice-black gram intercropping system

Treatment	Plant height (cm)	No. of branches $plant^{-1}$	No. of leaves $plant^{-1}$	Plants m^{-2}	Weight of individual plant (g)	Green fodder yield (t ha^{-1})	Dry fodder yield (t ha^{-1})
Black gram 50 kg seed ha^{-1} (sole) (T_2)	48.59 a	3.47 a	10.40 a	38.33 jk	47.87 a	12.49 kl	1.92 hi
Aus rice + Black gram 50 kg seed ha^{-1} (T_3)	48.05 ab	3.33 ab	10.33 ab	37.33 k	47.17 a	11.98 l	1.79 i
Black gram 55 kg seed ha^{-1} (sole) (T_4)	47.52 bc	3.27 a-c	10.13 ab	40.33 h-k	46.20 ab	13.46 ij	2.16 fg
Aus rice + Black gram 55 kg seed ha^{-1} (T_5)	47.13 cd	3.20 bc	10.00 ab	39.33 i-k	45.90 ab	13.04 jk	2.06 gh
Black gram 60 kg seed ha^{-1} (sole) (T_6)	46.51 de	3.13 b-d	9.73 a-c	42.33 f-i	44.93 a-c	14.44 gh	2.38 d-f
Aus rice + Black gram 60 kg seed ha^{-1} (T_7)	46.17 e	3.07 c-e	9.67 a-c	41.33 g-j	43.40 b-d	14.08 hi	2.31 ef

Black gram 65 kg seed ha^{-1} (sole) (T_8)	45.49 f	2.93 d-f	9.53 a-d	44.33 d-g	42.14 c-e	15.52 ef	2.70 a-c
Aus rice + Black gram 65 kg seed ha^{-1} (T_9)	45.15 f	2.87 e-g	9.40 b-e	43.33 e-h	42.03 de	15.04 fg	2.45 c-e
Black gram 70 kg seed ha^{-1} (sole) (T_{10})	44.51 g	2.80 f-h	8.93 c-f	46.33 b-e	40.73 d-f	16.47 cd	2.85 a
Aus rice + Black gram 70 kg seed ha^{-1} (T_{11})	44.18 g	2.73 f-i	8.80 c-f	45.33 c-f	39.54 e-g	16.07 de	2.37 d-f
Black gram 75 kg seed ha^{-1} (sole) (T_{12})	43.51 h	2.67 g-j	8.67 d-f	48.33 a-c	38.61 f-h	17.04 a-c	2.75 ab
Aus rice + Black gram 75 kg seed ha^{-1} (T_{13})	43.06 hi	2.60 h-j	8.53 ef	47.33 a-d	37.25 g-i	16.76 bc	2.613 a-d
Black gram 80 kg seed ha^{-1} (sole) (T_{14})	42.54 ij	2.53 ij	8.33 f	50.33 a	36.31 hi	17.52 a	2.60 b-d
Aus rice + Black gram 80 kg seed ha^{-1} (T_{15})	42.10 j	2.47 j	8.20 f	49.33 ab	35.35 i	17.27 ab	2.78 ab
CV (%)	0.83	4.38	5.54	4.60	3.79	2.53	5.50

In a column, figures having similar letters or without letter do not differ significantly whereas figures having dissimilar letters differ significantly as per Duncan's Multiple Range Test (DMRT).

Dry fodder yield

Dry fodder yield of blackgram was significantly affected by seed rate of blackgram in *Aus* rice-blackgram intercropping system and sole cropping. Higher dry fodder yield (2.85 t ha^{-1}) was observed in blackgram fodder sole cropping at 70 kg seed ha^{-1}, which was followed by blackgram sole cropping at 65 and 75 kg seed ha^{-1} and *Aus* rice in row + blackgram at 75 and 80 kg seed ha^{-1}. The lowest dry fodder yield (1.79 t ha^{-1}) was found in *Aus* rice in row + blackgram fodder at 50kg seed ha^{-1}, which was similar to blackgram fodder sole cropping at 50 kg seed ha^{-1}. Among the intercropping systems, dry fodder yield of blackgram showed the best performance (2.78 t ha^{-1}) in *Aus* rice in row + blackgram at 80 kg seed ha^{-1}. Variation of dry fodder yield of blackgram might be due to increasing seed rate in blackgram.

Economic analysis

Gross return

Gross return was significantly affected by seed rate of blackgram in *Aus* rice-blackgram intercropping system and sole cropping (Table 3). Higher gross return (Tk.64030 ha^{-1}) was observed in *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1} followed by *Aus* rice in row + blackgram fodder at 55 kg seed ha^{-1}. Similar results were reported by Kader et al. (1999) that gross return of *Aus* rice-mungbean fodder intercropping system was superior to sole cropping. The lowest gross return (Tk.12490 ha^{-1}) was found in blackgram fodder sole cropping at 50 kg seed ha^{-1}. Variation of gross return might be due to increase in blackgram

seed rate and intercropping with *Aus* rice, grain and straw yields of *Aus* rice, yield of fodder and market price of the products. All intercropping systems, showed superior performance in terms of gross return compared to sole cropping because of higher grain and straw yields.

Net return

Net return was significantly affected by seed rate of blackgram in *Aus* rice-blackgram intercropping system and sole cropping (Table 3). Higher net return (Tk.37180 ha^{-1}) was observed in *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1}, which was similar to *Aus* rice in row + blackgram fodder at 55 kg seed ha^{-1} (Tk.35460 ha^{-1}). The superiority of grain, straw and biological yields and harvest index of *Aus* rice in the intercropping systems showed the highest in net return. Similar results were reported by Sarma and Shyam (1992). The lowest net return (Tk.5663 ha^{-1}) was found in blackgram fodder sole cropping at 50 kg seed ha^{-1}, which was similar to blackgram fodder sole cropping at 55, 60, 65, 70, 75 and 80 kg seed ha^{-1}. The fodder crop of sole cropping at various seed rates showed inferior performance with respect to net return. Variation of net return might be due to higher gross return.

Table 3. Gross return, net return and benefit cost ratio in *Aus* rice-black gram intercropping system

Inter cropping treatment	Gross return (Tk ha^{-1})	Net return (Tk ha^{-1})	Benefit cost ratio (BCR)
Aus rice sole sown in 25 cm apart (T_1)	54410 g	26590 d	2.19 c
Black gram 50 kg seed ha^{-1} sole (T_2)	12490 m	5663 e	1.83 gh
Aus rice + Black gram 50 kg seed ha^{-1} (T_3)	64030 a	37180 a	2.38 a
Black gram 55 kg seed ha^{-1} sole (T_4)	13460 l	6235 e	1.86 fg
Aus rice + Black gram 55 kg seed ha^{-1} (T_5)	62640 b	35460 a	2.30 b
Black gram 60 kg seed ha^{-1} sole (T_6)	14480 k	6507 e	1.82 gh
Aus rice + Black gram 60 kg seed ha^{-1} (T_7)	60210 c	32590 b	2.18 c
Black gram 65 kg seed ha^{-1} sole (T_8)	15520 j	6930 e	1.81 gh
Aus rice + Black gram 65 kg seed ha^{-1} (T_9)	58830 d	30860 bc	2.11 d
Black gram 70 kg seed ha^{-1} sole (T_{10})	16470 i	7307 e	1.80 h
Aus rice + Black gram 70 kg seed ha^{-1} (T_{11})	57450 e	28760 cd	2.00 e
Black gram 75 kg seed ha^{-1} sole (T_{12})	17040 hi	7557 e	1.80 h
Aus rice + Black gram 75 kg seed ha^{-1} (T_{13})	56530 f	27620 d	1.96 e
Black gram 80 kg seed ha^{-1} sole (T_{14})	17520 h	7788 e	1.80 h
Aus rice + Black gram 80 kg seed ha^{-1} (T_{15})	55990 f	26570 d	1.90 f
CV (%)	1.07	7.07	1.61

In a column, figures having similar letters do not differ significantly whereas figures having dissimilar letters differ significantly as per DMRT.

Benefit cost ratio (BCR)

Benefit cost ratio was significantly affected by seed rate of blackgram in *Aus* rice-blackgram intercropping treatment and sole cropping (Table 3). Higher benefit cost ratio (2.38) was observed in *Aus* rice in row + blackgram fodder at 50 kg seed ha^{-1} followed by *Aus* rice in row + blackgram fodder at 55 kg seed ha^{-1} (2.30). The lowest benefit cost ratio (1.80) was found in blackgram fodder as sole cropping at all seed rates. Among all the treatments, intercropping showed higher BCR compared to sole cropping of *Aus* rice and blackgram. Singh (2007) also reported similar observation that intercropping recorded significantly higher benefit cost ratio

than their sole stand. The superiority of intercropping treatment with respect to gross and net returns showed the highest performance regarding benefit cost ratio.

ONCLUSION

From the results of *Aus* rice-blackgram intercropping treatment, it can be concluded that to minimize the deficit of fodder in the country with minimum rice grain yield loss and higher monetary benefit in *Aus* rice row sowing 25 cm apart, blackgram fodder sown at 50 kg seed ha^{-1} would be the promising fodder production technology.

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