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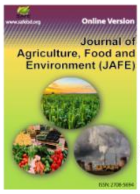

Original Article

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Mulching Techniques for Enhanced Yield in Non-Saline Coastal Bangladesh

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A B S T R A C T

Agricultural water resources have been constrained over the years due to climate change. Mulching significantly lessens water stress in agriculture, making it an effective water-conservation method in Bangladesh's coastal region. This study examines suitable cropping patterns for the non-saline south-central coast of Bangladesh, aiming to enhance agricultural productivity and resource efficiency in the region. The experiment was conducted in a farmer's field in Patuakhali district from May 2019 to May 2020. The experiment evaluated the performance of five cropping patterns (Mungbean- Fallow-Transplanted Aman rice, Cowpea-Aus rice-Transplanted Aman rice, Mungbean-Aus rice-Transplanted Aman rice, Maize- Aus rice-Transplanted Aman rice, Sunflower-Aus rice-Transplanted Aman rice) with mulching and no mulching treatment. The experiment was designed using a split-plot with 3 replications. Mulching treatment crop yields were higher compared to the no-mulching treatment, primarily due to higher soil moisture. Moreover, among all the dry-season crops, the highest seed yield was obtained from maize (8.54 t/ha). Overall, this study found that Aus rice-T. Aman rice-Sunflower with mulching was the most profitable cropping pattern. Mulching treatment was found to be more beneficial for higher yields and a better benefit-cost ratio (BCR) across all crops. The BCR for this cropping pattern under mulching was 1.77, with a rice equivalent yield (REY) of 21.08. The findings of this study may help policymakers formulate policies to enhance cropping intensity in Bangladesh's coastal areas.

INTRODUCTION

Globally, regions facing arid and semi-arid climates are confronting escalating threats from water scarcity, land degradation, and climate unpredictability, all of which undermine the viability of farming systems (El-Hendawy *et al.*, 2023). Agriculture in Bangladesh, especially in coastal regions, is heavily impacted by climate change. Environmental changes have increasingly hampered the region's long-standing farming methods, modifying the entire crop calendar (Bhuyan *et al.*, 2023a). Mulching, which has garnered significant attention globally, is an effective technique for conserving moisture. The practice of mulching involves covering organic mulches (like residues, straw, and wood chips), which add organic matter that advances soil moisture, structure, and cycling of nutrients, while inorganic mulches (like plastic films) warm the soil to encourage early growth and increase yields (Hussain *et al.*, 2022 and Li *et al.*, 2018).

In Bangladesh, the Rabi season, which runs from October to May, holds significant importance as a window for growing high-value crops, including wheat, maize, sesame, sunflower, and boro rice. One of the primary issues arises from the delayed harvesting of T. Aman rice, which has a direct impact on the cultivation of dry-season crops (Bhuyan *et al.*, 2023b). The harvesting of T. Aman rice typically occurs in late November or early December; however, due to reduced drainage and waterlogging, residual soil moisture decreases rapidly, making it challenging to sow dry-season crops with adequate moisture levels (Bhuyan *et al.*, 2024; Haque *et al.*, 2025). Approximately 0.28 million hectares of coastal cropland can be irrigated with river water with a salinity level of less than 2 dS m^{-1}. This irrigation strategy could potentially minimize the impact on river salinity and improve agricultural productivity under current conditions and moderate climate change scenarios (Khan *et al*., 2024). Several studies have highlighted the benefits of mulching in various agricultural systems, particularly in soil moisture conservation, improving crop productivity, as well as enhancing water use efficiency (El-Beltagi *et al*., 2022;).

A reliance on residual soil moisture for dry-season crops often results in low yields—ranging from 0.5 to 1.0 tons/ha, compared to 2.0 to 3.5 tons/ha under irrigated conditions (Paul *et al*., 2021). While there are potential solutions, such as incorporating rice straw into the soil or retaining it on the surface, these strategies can significantly enrich soil organic carbon and improve nutrient availability for subsequent crops. Research has consistently shown that mulching can significantly improve crop yields. In some cases, yield rises have ranged from 7% to 47% depending on the type of mulch used and the crop under consideration (Jahan *et al*., 2024). This practice not only benefits crop yields but also provides long-term climate-adaptation benefits, especially in regions affected by erratic rainfall and soil degradation (Rahaman *et al*., 2024).

So far, only a few studies (e.g., Islam *et al*., 2022; Hasan *et al*., 2019) have been done in selected south-central coastline districts of Bangladesh to investigate the impacts of salinity on dry-season crops. However, a complete study on the suitability of potential cropping patterns for the southern coast of Bangladesh is still needed to increase cropping intensity. The aim of this research is to evaluate sustainable moisture-conservation methods for dry-season crops and to assess the agro-economic performance of the proposed cropping systems in non-saline coastal areas of Bangladesh.

MATERIALS AND METHODS

Study Area

The research plot is located at latitude of 22°27.816' N and a longitude of 90°23.218' E, at an elevation of approximately 3.0 meters above sea level. The area is primarily enclosed by the Ganges tidal floodplains and falls under Agro-ecological Zone (AEZ) 13. The climate is subtropical, with relatively high temperatures and significant precipitation during the Kharif season (April-September), and lower precipitation with mild to cold temperatures during the dry season. The soil is fine-textured, becoming progressively siltier towards the east.

Experimental Materials

Planting Materials and Source

The seeds of Aus rice (BRRI dhan55) were obtained from the Bangladesh Agricultural Development Corporation, while the transplanted Aman rice (BRRI dhan77) seed were acquired from the Bangladesh Rice Research Institute. The crops, including mungbean seeds (BARI Mung -6), were obtained from the Bangladesh Agricultural Research Institute, while Cowpea seeds were sourced from local market in Dumki. Sunflower seeds (Hysun33) and maize seeds (DON111) were also composed from the local marketplace. All the seeds were healthy, pure, and free from contamination by other seeds, weed seeds, and inert materials.

Treatments

A. Mulching for dry season crops: 2 (Mulching and no mulching).

B. Cropping pattern: 5

Mungbean (BARI mung6) – Fallow- Transplanted Aman rice (Moulata)

cowpea (local)- Aus rice (BRRI dhan55)- Transplanted Aman rice (BRRI dhan77)

Mungbean(BARI mung6)- Aus rice (BRRI dhan55)- Transplanted Aman rice (BRRI dhan77)

Maize (DON111)- Aus rice (BRRI dhan55)- Transplanted Aman rice (BRRI dhan77)

Sunflower (Hysun33)- Aus rice (BRRI dhan55)- Transplanted Aman rice (BRRI dhan77)

Experimental Design and Layout

The experimental plot was organized in a two-factor design. Split plot design with 3 replications, with mulching and cropping patterns allocated in the main and subplots. Farmers were selected following a baseline survey and interactions with Department of Agricultural Extension officials, BARI, BRRI, and IRRI scientists. Each farmer was treated as a single replication. The experiment used a plot extent of 5 × 2.5 m. Each farmer was trained to carry out the trials. In both studies, the distance between subplots was 0.50 m. In the mulching experiment, the spacing between plots was 1.0 m.

Crop establishment and management

Aus rice

BRRI dhan55 was transplanted during June 1–2, 2019, in a 20 cm × 20 cm design, with 2–3 seedlings hill^{-1}, following power tiller puddling with three passes. Fertilization was conducted according to the Fertilizer Recommendation Guide (BARC, 2012), based on soil test results. Stem borer was controlled using Agrifuran at 10 kg ha^{-1} applied 20 days after transplanting. Harvest was done on August 13, 2019.

Transplanted Aman rice

Transplanted Aman rice was moved during (August 21–22, 2019) using the popular variety Moulata and BRRI dhan77, a tidal flood-resistant variety. Seedlings were transplanted at 20 cm × 20 cm spacing with 3–4 seedlingshill^{-1}. Fertilizer and pest management followed the same recommendations as Aus rice. Harvest was done in late December.

Dry Season crops

Following the Aman rice harvest in late December, mulching treatments were applied under identical conditions at both sites. On January 20, 2020, seeds for all dry season crops were planted in Dumki Upazilla (sub-district). The seeds were manually sown in furrows created by a line, with a sowing penetration of approximately 4-5 cm for all crops.

Farmers in the experimental area generally use a low seed rate of 30-35 kg ha^{-1} with the spreading method. To maintain consistency with local practices, 30 kg/ha of seed was used. The recommended spacing for sunflowers is 50×25 cm, which was applied in the mulching experiment. In this study, straw mulch was applied at 5 t ha^{-1} between two rows immediately after sowing. At the experimental site in a non-saline ecosystem, one manual weeding was performed for all pulse crops. All other cultural practices followed BARI guidelines. All dry-season crops were harvested at maturity, when 80% of the grains or pods had developed.

Economic analysis

Profitability of the cropping systems was measured by calculating their variable costs, gross and net returns, and benefit–cost ratios. The inputs required per hectare were noted, and their costs were based on regional market rates. Returns were assessed using local prices for paddy and dry season crops.

Rice equivalent yield

In this research work, three crops (2 rice and 1Rabi) were involved in each cropping pattern and these were heterogeneous. So, use of total weight for all products could not be compared as sole index productivity. Therefore, a single productivity index was used, either monetary or main crop equivalent yield. While Aus and Transplanted aman rice are the principal crops, the equivalent yield of the dry season crop was converted into Aus and Transplanted aman rice equivalent yield (REY) based on product prices as shown below.

REY ((t/ha)) of dry season crop =

Yield (Tk.t/ha) of dry season crop × Price (Tk.t/ha)) of dry season crop Price (Tk.t/ha)) of rice

REY of the cropping pattern = Yield (t/ha) of rice (Aus + Aman) + REY (t/ha) of dry season crop

Statistical Analysis

The data collected on crop characteristics were analyzed using the Mstat-C statistical program (Michigan State University, East Lansing, MI, USA), following the principles outlined by Gomez and Gomez (1984). The significance of treatment effects was assessed through analysis of variance (ANOVA), and treatment means were compared at the 5% significance level using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Yield performance

Aus rice

Table 1 show that the average yield of Transplanted Aus rice across three farmers' fields was 3.73 tha^{-1}, which is notably lower than that of Transplanted Aman rice. This reduction can be primarily attributed to climatic conditions during the Aus season. Elevated temperatures often lead to shortened growth duration and a condensed grain-filling period, ultimately reducing grain yield (Rushsa *et al.*, 2023). Additionally, cloudy weather limits solar radiation, thereby decreasing photosynthetic activity and dry matter accumulation (Rushsa *et al.*, 2023). These factors likely contribute to the observed lower yields. These results are in agreement with those of Islam *et al.* (2015), who discovered that temperatures above 30°C during the reproductive stages can lead to sterility.

Aman Rice

In the Kharif-2 season, two T. Aman rice varieties were tested under non-saline tidal conditions (Table 1). BRRI dhan77, a modern rice variety tolerant to tidal submergence, produced a greater yield (5.30 tha^{-1} than the traditional variety Moulata (3.81 tha^{-1}). The reduced yield in Moulata was mainly linked to its strong tendency to lodge, particularly during the dough stage. Field observations showed that nearly all Moulata plants had dropped over, which restricted photosynthesis and hindered proper grain filling. In contrast, BRRI dhan77 remained upright during critical growth periods, allowing for more efficient light interception and nutrient movement. These findings align with those of Khobra *et al.* (2019), who demonstrated that high-yielding cultivars have superior lodging resistance and higher yields in comparable agroecological environments.

Table 1: Yield of Aus and Transplanted aman rice of experimental field

Location	Aus rice			Aman rice		
	Variety	Yield of Grain (tha^{-1})	Maturity (days)	Variety	Yield of Grain (tha^{-1})	Maturity (days)
Patuakhali	BRRI dhan55	3.73	101	BRRI dhan77	5.30	146
				Moulata	3.81	154

Soil moisture variation under mulching

Figure 1 shows the soil moisture data. As shown in the figure, the mulching plot consistently retained higher soil moisture after seeding than the non-mulching plot. The highest soil moisture content (22.70%) at a 15 cm soil depth was recorded on the sowing date under mulching practices, compared to 20.55% under non-mulching. The increased soil moisture under mulching is likely due to reduced soil disturbance, limited exposure to air and sunlight, which minimizes evaporation, and a soil surface protected by rice straw, in contrast to the non-mulching plot

This higher moisture retention is due to reduced soil disturbance, decreased evaporation, and the protective cover of rice straw, which conserves moisture more effectively (Kader *et al.*, 2019). Previous studies have also confirmed that mulching enhances soil water retention by reducing evaporation and improving infiltration (Tan *et al.*, 2019). Additionally, the mulch layer minimizes temperature fluctuations, thereby preventing rapid moisture loss (Shaikh *et al.*, 2023). As a result, crops grown under mulching conditions perform better and yield higher due to the availability of adequate moisture throughout the growing period (Xiao *et al.*, 2023). Tan *et al.* (2019) further observed significantly higher wheat yields in mulched plots, attributing the improvement to better soil moisture retention and reduced water stress during critical growth stages.

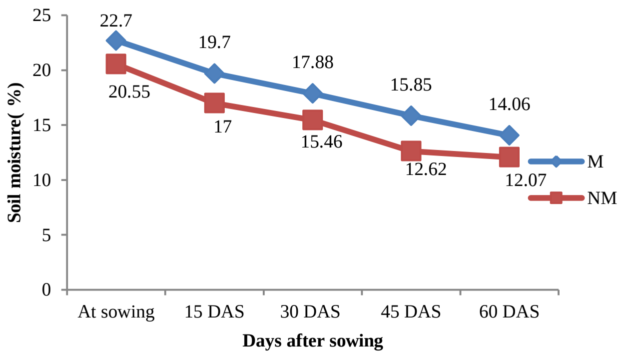

Figure 1: Variation of Soil moisture in dry season crop field after seeding in non-saline area of Patuakhali district under mulching (M) and no-mulching (NM) condition.

Plant population

Plant populations of mung bean, cowpea, maize, and sunflower were consistently higher under mulching compared to non-mulched conditions in the non-saline ecosystem. The improved plant stand in mulched plots can be attributed to the more favorable micro-environment created around the germinating seeds and young seedlings. Mulching has been shown to conserve soil moisture, reduce surface hardness, and maintain a looser soil structure in the root zone, which promotes better root penetration and early seedling vigor (Kader *et al*., 2019). These conditions reduce seedling stress and mortality, resulting in a higher and more uniform plant population. Similar findings have been reported in earlier studies, where mulch application enhanced seedling emergence and stand establishment by improving soil moisture availability and reducing evaporative losses (Song *et al*., 2023).

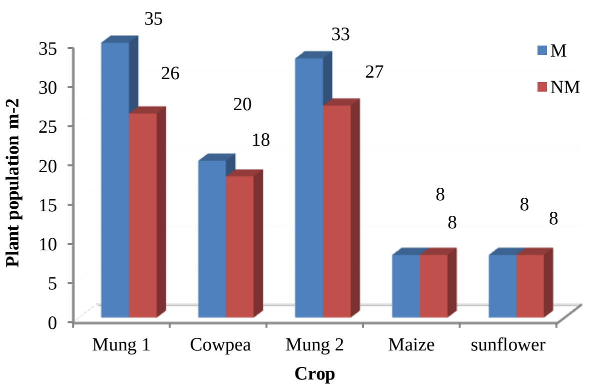

Figure 2: Plant population of different dry season crops at harvest in non-saline system of Patuakhali district under mulching (M) and no mulching (NM)

Mung1= Mungbean sowing after Moulata rice cultivation

Mung 2= Mungbean sowing after BRRI dhan77cultivation

Interaction effect of mulching and plant height

The interaction between mulching and plant height had a significant effect (Fig. 3). The tallest plant (191.06 cm) was observed with mulching in sunflower, while the lowest plant (37.14 cm) was noted in mungbean without mulching, attributed to variations in moisture. This difference was due to the moisture variation.

Similarly, Wang *et al.* (2020) observed that Mulched plots produced greater plant height compared to the treatment without mulch. Moreover, Ly *et al.* (2018) reported that mulching consistently improved plant height due to better soil moisture and favorable root-zone conditions.

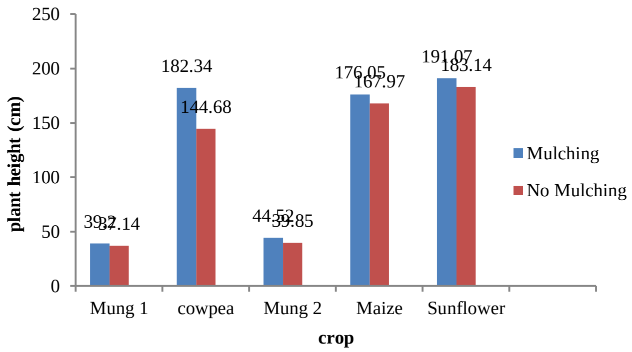

Figure 3: Interaction effect of mulching and crops on plant height

Interaction effect of mulching and crop on number of fruit plant^{-1}

The number of fruit plant-1 was significantly affected by the interaction effect of mulching and crop (Table 2). The highest number of fruit plant^{-1} (11.13) was produced by the treatment combination of mungbean mulching after BRRI dhan77 cultivation. The lowest value (1.00) was observed in the treatment combinations of no mulching with maize and sunflower, as well as in the treatment combination of mulching with sunflower.

Enhanced fruit production under mulched mungbean may be attributed to better soil moisture and moderated temperature conditions that support pod and fruit development. Similar improvements in fruit setting under mulching were noted by Cheng *et al.* (2021) and Hailu and Bogale (2024). Their study confirmed that better soil moisture and improved root-zone conditions under mulching enable enhanced reproductive processes and contribute to greater expression of yield components in crops.

Interaction effect of mulching and crops on number of seed fruit^{-1}

The number of seeds fruit-1 was not significantly affected by the interaction effect of mulching and crop (Table 2). The highest number of seeds fruit^{-1} (841.53) was found from the treatment combination of mulching with sunflower. The lowest number of seeds fruit^{-1}(7.66) was from the treatment combination of no mulching with mung 1 and mung 2.

Although the interaction effect was statistically non-significant, these trends suggest that mulching can still support seed development by improving moisture retention and moderating soil temperature. Similar observations were reported by Hailu and Bogale (2024), who found that mulching, enhances reproductive efficiency by maintaining stable soil moisture during critical stages of seed setting. Likewise, Bekele *et al.* (2023) confirmed that mulch-induced improvement in soil hydrothermal properties contributes to better seed formation and yield attributes in dry-season cropping systems.

Table 2: Interaction effect of mulching and crops on no. of fruit/plant, no. of seed/fruit and 1000 seed weight

Mulching	Crop	No of fruit plant^{-1}	No of seed fruit^{-1}	1000 seed weight
Mulching	Mung 1	8.600	9.600	47.57
	Cowpea	8.467	15.67	105.5
	Mung 2	11.13	8.733	49.24
	Maize	1.330	569.1	279.1
	Sunflower	1.000	841.5	52.50
No mulching	Mung 1	6.067	7.667	44.03
	Cowpea	7.000	15.13	100.7
	Mung 2	10.533	7.667	49.01
	Maize	1.000	551.3	240.5
	Sunflower	1.000	766.2	49.87
LSD		1.086	19.74	1.086
Level of significance		*	**	**
CV (%)		11.18	4.08	0.62

*= Significant at 5% level of probability, **= Significant at 1% level of probability and NS= non-significant
Mung1= Mungbean sowing after Moulata rice cultivation
Mung 2= Mungbean sowing after BRRI dhan77cultivation

Interaction effect of mulching and crops on 1000 seed wt

1000-seed weight was significantly affected by the interaction effect of mulching and crop (Table 2). The treatment combination of mulching with maize produced the highest 1000-seed weight (279.06 g). The lowest 1000-seed weight (44.03 g) was from the treatment combination of no mulching with mung1. These findings suggest that mulching improves seed development by maintaining adequate soil moisture and moderating temperature fluctuations during grain filling. Similar results were stated by Bekele and Mengasha (2023), who observed that mulching increases seed weight and grain quality by reducing moisture stress and enhancing root-zone hydrothermal conditions, particularly in dry-season cropping systems. Singh *et al.* (2008) observed that all polythene mulch-treated plots produced a higher weight of 200 seeds compared to the relevant irrigation treatment without polythene mulch (16.3).

Interaction effect of mulching and crops on maturity (days)

Days to maturity were not significantly affected by the mulching × crop interaction (Table 3). In general, mulching treatment required slightly more days to maturity than no mulching treatment. This may be due to higher soil moisture, which inhibits leaf senescence. Maize took the longest to attain maturity, and mung bean took the shortest. The life span of mungbean ranged from 87 to 90 days, cowpea from 101 to 104 days, maize from 114 to 118 days, and sunflower from 102 to 106 days, depending on mulching. Similar trends were reported by El-Beltagi *et al.* (2024), who found that mulching can slightly prolong crop maturity by improving soil moisture retention and moderating temperature conditions, thereby maintaining physiological activity for a longer period.

Interaction effect of mulching and crops on yield (seed)

The interaction effect of mulching and crop had a significant effect on seed yield (Table 3). The performance of mulching with maize was found to be superior to other treatment combinations, with the highest seed yield ($^{-1}$) and the lowest seed yield (0.56 t/ha) recorded from no mulching with mung. Siddique *et al.* (2004) described that mulching with rice straw resulted in significantly higher mungbean yields compared to the no-mulching treatment. Singh *et al.* (2011) ~~1986b)~~ reported that mulched plots yielded higher seed counts than no mulched plots, which was attributed to a greater number of pods per plant. All the dry-season crops showed better performance with straw mulching compared to no mulching in a non-saline ecosystem, due to the increased availability of moisture.

Moazzamnia *et al.* (2025) found that mulching can slightly delay crop maturity due to improved soil moisture retention and moderated temperature conditions that maintain physiological activity for longer.

Table 3: Interaction effect of tillage and crops on Days to maturity, seed yield and straw yield

Treatment	Crop	Maturity (days)	Yield of seed (t/ha)	Yield of straw (t/ha)
Mulching	Mung 1	90.00	0.5767	0.823
	Cowpea	104.0	2.1900	3.087
	Mung 2	90.00	0.9200	1.080
	Maize	115.0	9.0500	9.500
	Sunflower	102.0	3.5330	5.790
No mulching	Mung 1	82.00	0.5600	0.737
	Cowpea	101.0	1.5970	2.370
	Mung 2	84.00	0.8100	0.990
	Maize	110.0	8.1070	9.130
	Sunflower	96.00	2.9730	5.500
LSD		3.168	0.4447	0.154
Level of significance		NS	**	**
CV (%)		1.88	8.39	2.25

*= Significant at 5% level of probability, **= Significant at 1% level of probability and NS= non-significant
Mung1= Mungbean sowing after Moulata rice cultivation
Mung 2= Mungbean sowing after BRRI dhan77cultivation

Interaction effect of mulching and crops on yield (straw)

Table 3 shows that the interaction of mulching and crop straw yield. The maximum straw yield (9.50 tha^{-1}) was found from mulching with maize. The lowest straw yield (0.73 tha^{-1}) was recorded from no mulching with mungbean after moulata rice cultivation.

Mulching with maize resulted in the highest straw yield (9.50 tha^{-1}), reflecting improved biomass accumulation due to enhanced soil moisture and moderated soil temperature. Conversely, the lowest straw yield (0.73 tha^{-1}) was recorded in the no-mulching treatment with mungbean following moulata rice. These results indicate that mulching promotes greater vegetative growth and straw production, particularly in crops with higher biomass potential such as maize. Similar findings were reported by El-Beltagi *et al.* (2022), who observed that mulching increases above-ground biomass due to improved soil hydrothermal conditions and reduced moisture stress, ultimately contributing to higher straw yields in dry-season cropping systems.

Agro-economic performance of cropping system under mulching systems

In a non-saline ecosystem, the analysis of costs and returns showed that the highest gross return (Tk. 458,550 ha^{-1}), net return (Tk. 258,600 ha^{-1}), and BCR (1.77) were accomplished with the cropping system of Sunflower- Aus rice- Transplanted aman rice (mulching), due to higher yields and better output (seed) prices from soybean with mulching (Table 4). In contrast, the farmers' practice of Mungbean-Fallow – Transplanted aman rice (mulching and broadcasting of seed) had the lowest cost (Tk. 94,750ha^{-1}) but did not outcome in advanced gross return (Tk. 118,080 ha^{-1}), net return (Tk. 23,330ha^{-1}), or BCR (1.25).

Table 4: Agro-economic performance of different cropping systems under mulching and no mulching conditions in non-saline system

Sl. No.	Cropping System	Seed yield (t/ha)	Straw yield (t/ha)	Gross return (Tk/ha)	TVC (Tk/ha)	Net benefits (Tk/ha)
1	Mungbean****	o.61	0.83	32160	30500	1660
	Aus rice	3.81	6.20	89400	65850	23230
	Transplanted aman rice	3.73	4.30	101850	73650	28200
	Total			223410	170320	53090
2	Mungbean***	0.56	0.74	29480	28900	580
	Fallow	-	-	-	-	-
	Transplanted aman rice	3.81	6.20	88600	65850	22750
	Total			118080	94750	23330
3	Cowpea*	2.19	3.08	82810	38850	43960
	Aus rice	3.73	4.30	101850	73650	28200
	Transplanted aman rice	5.30	6.60	98000	66170	31830
	Total			282660	178670	103990
4	Cowpea**	1.60	2.37	60740	34680	26060
	Aus rice	3.73	4.30	101850	73650	28200
	Transplanted aman rice	5.30	6.60	98000	66170	31830
	Total			260590	174500	86090
5	Mungbean *	0.92	1.08	48160	32710	15450
	Aus rice	3.73	4.30	101850	73650	28200
	Transplanted aman rice	5.30	6.60	98000	66170	31830
	Total			248010	172530	75480
6	Mungbean**	0.80	0.99	41980	30100	11880
	Aus rice	3.73	4.30	101850	73650	28200
	Transplanted aman rice	5.30	6.60	98000	66170	31830
	Total			241830	169920	71910
7	Maize *	8.97	9.50	198400	126564	71836
	Aus rice	3.73	4.30	101850	73650	28200
	Transplanted aman rice	5.30	6.60	98000	66170	31830
	Total			398250	266384	131866
8	Maize **	8.11	9.13	180460	121332	59128
	Aus rice	3.73	4.30	101850	73650	28200
	Transplanted aman rice	5.30	6.60	98000	66170	31830
	Total			380310	261152	119158
9	Sunflower *	3.53	5.80	258700	118780	139920
	Aus rice	3.73	4.30	101850	73650	28200
	Transplanted aman rice	5.30	6.60	98000	66170	31830
	Total			458550	258600	199950
10	Sunflower**	2.97	5.50	218900	113460	105440
	Aus rice	3.73	4.30	101850	73650	28200
	Transplanted aman rice	5.30	6.60	98000	66170	31830
	Total			418750	253280	165470

*= Mulching and sowing (line)
**= No-mulching and sowing (line)
*** = No-mulching and sowing (broadcast)
BCR= Benefit cost ratio
TVC= Total variable cost
****= Mulching and sowing (broadcast)

Rice equivalent yield of cropping systems under mulching and no mulching conditions

Table 5 shows the REY of various cropping systems. In a non-saline ecosystem, all cropping systems yielded significantly higher REYs than the farmers' traditional system. The inclusion of new crops, such as sunflower and maize with straw, contributed to higher REY in these systems. Among the components, sunflower made the largest contribution to the REY, followed by Aman rice in second place, and Aus rice in third, within a similar cropping system.

In a non-saline system, the highest REY (21.08 t ha^{-1}) was achieved with sunflower (mulching)- Aus rice- Transplanted aman rice cropping system, with the component-wise contributions of 18:25:57 (Sunflower: Aus: Aman:). In contrast, the lowest REY (5.21 t ha^{-1}) was recorded from the farmers' system, Mungbean (no mulching and broadcasting) Fallow- T. Aman rice (Moulata), with component-wise contributions of 73:27 (Mungbean: Aman). Similar results were observed in a saline ecosystem, where the same cropping system produced the highest REY.

Table 5: Rice equivalent yield and benefit cost ratio of different cropping arrangements under mulching and no mulching conditions in non-saline area

Sl. no.	Cropping system	REY of the system	Component wise contribution (%) to REY	BCR of the component crop	BCR of the system
	Mungbean****		17	1.05	
1.	Aus rice		41	1.38	
	Transplanted aman rice	9.02	42	1.48	1.36
	Mungbean***		27	1.02	
2.	Fallow	5.21	-	-	1.25
	Transplanted aman rice		73	1.35	
	Cowpea *		30	2.13	
3.	Aus rice	12.77	29	1.38	1.58
	Transplanted aman rice		41	1.48	
	Cowpea **		23	1.75	
4.	Aus rice	11.76	32	1.38	1.49
	Transplanted aman rice		45	1.48	
	Mungbean *		20	1.47	
5.	Aus rice	11.27	33	1.38	
	Transplanted aman rice		47	1.48	1.43
	Mungbean**		18	1.39	
6.	Aus rice	10.98	34	1.38	1.42
	Transplanted aman rice		48	1.48	
	Maize *		49	1.57	
7.	Aus rice	17.78	21	1.38	1.49
	Transplanted aman rice		30	1.48	
	Maize **		47	1.49	
8.	Aus rice	16.94	22	1.38	1.46
	Transplanted aman rice		31	1.48	
	Sunflower*		57	2.22	
9.	Aus rice	21.08	18	1.38	1.77
	Transplanted aman rice		25	1.48	
	Sunflower**		53	1.92	
10.	Aus rice	19.17	19	1.38	1.65
	Transplanted aman rice		28	1.48	
LSD (0.05)		0.83			NS
CV(%)		3.52			6.15

*= Mulching and sowing (line)
****= Mulching and sowing (broadcast)
*** = No-mulching and sowing (broadcast)
**= No-mulching and sowing (line)

CONCLUSION

The field study was conducted in the non-saline south-central coastal region to determine how the yield and yield components of different dry-season crops were affected by mulching, as well as the effects of mulching on REY and BCR. Mulch protects the soil surface from direct sunlight, reducing evaporation, preserving soil moisture, and altering soil temperature. The findings revealed that mulching had a much greater favorable impact on dry season crop yields and yield-contributing attributes than no mulching. It also consistently increased yield and BCR across all crops. Among the examined planting patterns, Sunflower-Aus rice-Transplanted Aman rice with mulching was the most cost-effective under non-saline conditions. Under mulching, this design had the highest REY and BCR. These findings can help policymakers develop future climate-smart adaptation plans. Furthermore, this study concentrates merely on the non-saline south-central coast of Bangladesh. Future studies should focus on saline areas to obtain comprehensive data.

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