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Employment Generation of Agricultural Day Labourers during Lean Period through Adjustment of Short Duration Rice Variety in Rice-Based Cropping Pattern in Northern Bangladesh

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Abstract

A series of experiments was conducted at the RDRS Farm, Rangpur, Bangladesh during *aman* season in 2014 and 2015. The overall objective was to find out the employment generation of day labourers during lean period (mid-September to mid-November) on the effect of direct seeding and transplanting system of short duration variety of *aman* rice in *Aman* rice-Potato-Mung bean cropping pattern. In 2014, a short duration *aman* variety (BRRI Dhan33) with three planting dates and two planting methods was tested through on-station research to identify suitable time of planting in support of early harvest during lean period. In 2015, the same experiment with two *aman* varieties under three planting dates and the two planting methods was also tested for the same purpose. Crop duration was reduced to 100 days with 30th June planting of BRRI Dhan33 and 128 days with 15th and 30th June planting of BR11 under direct seeding compared to all other planting dates of BRRI Dhan33 (120 days) and BR11 (150 days). The crop duration of both the varieties (BRRI dhan33 and BR11) was decreased by around 20 days due to direct seeding system. Due to harvest of rice in lean period, a total of 60 labourers were employed per hectare for the operations *viz.* harvesting, threshing, drying and storing, which would have been otherwise done in December. The sensitivity analysis indicates a huge potential of BRRI dhan33 as a future model to replicate in a wider farming community of seasonal crisis affected areas in northwest Bangladesh. The overall result indicates that the crops under direct seeding of BRRI Dhan33 in late June and under transplanting of the same variety upon seeding of mid June were harvested during peak lean period, which created a significant access of day labourers to employment. The result also implies that because of early harvest of rice, the succeeding crops (potato and mungbean) could be established in due time and thus performed better compared to their traditional planting.

Keywords: Direct seeding, short duration rice variety, early harvest, lean period

Introduction

The poor people of northern part of Bangladesh suffer acute deprivation during lean period caused by their lack of purchasing power arising from seasonal scarcity of gainful employment. This acute seasonal distress recurs each year as an inherent feature of northern Bangladesh especially greater Rangpur districts, which is very dependent on agriculture. Available evidences indicate that the people of northern Bangladesh are facing severe food insecurity every year as compared to other parts of the country.

In two periods of each year (between the month of mid-September to mid-November and mid-March to mid-May), the rural poor who rely on farm work regularly suffer severe seasonal hardship, when household food availability and farm employment dries up. Mid-March to mid-April lean season also brings hardship but this is now less severe or lengthy due to recent crop versification in the northern region, such as

maize, potato, winter vegetables, wheat, etc. are now cultivated by the farmers and spreading the seasonal load of work and food supply. Nowadays, the most serious lean season occurs in mid-September to mid-November (*Ashwin – Kartik* as *Bangla* months) each year, when many people are affected by seasonal crisis. When this period arrives, the food stocks of the poor people have been heavily depleted, while opportunities for farm labouring work dried up before the next peak, which falls during the main rice harvest in December. Hence, the poor living in these month can pass days and even months with very little work and therefore income. These families may have to survive an extended period without proper meals.

Table 1 Comparison of households in distress of different area during lean period.

Divisions	% households in distress: (1 meal/day for 1-3 days a week)	% households in extreme distress (1 meal a day for 4-7 days a week)
Chittagong	6	X
Khulna	1	X
Dhaka	3	X
Rajshahi	18	13
Affected Districts		
Greater Rangpur	25	26
Greater Dinajpur	11	X
Greater Bogra	28	X
Greater Rajshahi	12	2
Greater Jamalpur	12	X

Source: Survey report conducted in 1990 (Rahman, 1995)

Normally in northern Bangladesh, almost hundred percent farmers are cultivating monsoon rice crop (see Table 2). Most of the farmers cultivate a long duration verity of monsoon rice (requiring 145 – 160 days) such as BR11, *Shwarna*, etc. These verities require them to prepare the seed bed and sow seeds in late June and then transplant the rice seedlings to their main field and then intercultural operations, top-dressing, etc. to be done in July and August. After that, there is a little farming field operation required from mid-September to mid-November in the rice field and this is the main cause of seasonal crisis. Since monsoon rice (*Aman*) cultivation is universal so more than 70% of day labourers and hardcore poor households are fully dependent on employment in various stages of rice cultivation. Hence, there are few alternative job opportunities in mid-September to mid-November period.

The cropping patterns shown above are most commonly practiced in northern Bangladesh. It is observed that farmers are now following diversified cropping patterns in the *rabi*/winter season (irrigated rice/*boro*), but not in monsoon (*aman*) season. It may also be pointed that opportunity for crop diversification in monsoon period is also too minimum due to heavy rainfall during these months. This causes joblessness in agricultural field in the month of mid-September, October and mid-November, where no work is required by the *aman* rice crop, until harvesting in late November and December.

On the other hand, farmers are facing serious problems to cultivate potato and wheat in right time (in November). Normally in high and medium high land, farmers go for wheat/ potato/winter vegetables cultivation after harvesting of *aman* rice. The proper time to cultivate these crops in northern Bangladesh is in November. But due to presence of *aman* rice crops in most of the lands in November, farmers have no scope to avail the right time to cultivate such winter crops. This delayed cultivation hampers the normal yield and also increases the production cost of different winter crops. Secondly, around 50% of potato farmers and almost hundred percent of wheat farmers are

waiting to cultivate *aman* rice in July after harvesting of potato and wheat in March and April respectively. A short duration pulses crop like Mungbean may be introduced to make an alternative early rice-potato-mungbean cropping pattern, which will eventually increases cropping intensity as well as improves soil quality due to inclusion of mungbean as a soil resovalent crop.

Direct seeding is an alternative method of rice crop establishment, which requires less production cost and less time but higher yield. In this method, pre-germinated rice seed are directly sown by drum seeder on paddled soil/clay soil in the main field. This method reduces the life duration by 15 to 20 days compared to transplanted rice, because direct seeded rice may escape transplanting shock and injury. Direct seeded rice will also give about 15% higher grain yield over the transplanted rice (Ding et al., 1999). It is reported that direct seeded rice required about 20% less water compared with transplanted rice (Sattar and Khan, 1994). It is also reported that direct seeded rice reduced 2 – 6% production cost and increased net return by 15 to 30 percent (Isvilanonda, 2002).

Table 2: Existing six different cropping patterns practiced by farmers in northern Bangladesh

Sl. No.	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
1		Boro rice							Aman	rice		
2		Tobacco							Aman	rice		
3		Maize							Aman	rice		
4		Potato			Maize				Aman	rice		
5		Wheat							Aman	rice		
6	Potato	/w.veg			Jute				Aman	rice		
7	Potato			Late	boro				Aman	rice		

Cropping pattern for mitigation seasonal crisis

	Potato		Mung	bean					SD rice		Potato	
	Potato		Late	Boro					SD Rice		Potato	

In direct seeded technology, land should be leveled where irrigation/rain water is required, so that germinated seeds or small seedlings will not go under water. Farmers are reluctant to use irrigation water in *aman* rice rather depend on rainwater. In adequate rainwater in late June is not convenient to prepare puddle soil for drum seeding or direct seeding. Also weed infestation is a problem in direct seeding technology. In order to overcome such limitations, a new device named Power Tiller Operated Dry Seeder (PTODS) could be used instead of Drum Seeder, where puddling field is not required before seed sowing. Through this PTODS, it is possible to sow the dry seeds directly in the main field just with available soil moisture condition.

Weeds could be controlled easily under direct seeding by drum seeder/PTODS. These seeders allow plant establishment in lines and thus allows mechanical weeding using push weeders or herbicides. Row seeding using drum seeder /PTODS was reported to have increased grain yield of 0.43 to 0.75 ton per hectare and farmers income will be increased by an average of 10 to 30% compared to transplanting system. However, the use of drum seeder/PTODS is quite new in Bangladesh.

Also when farmers will be able to cultivate potato/wheat in right time (in November),

farmers will get more yield for timely cultivation and side by side could be able to minimize the production cost by reducing use of pesticides especially for potato cultivation and use of laborers for transplanting of seedlings. It is reported that seed sowing of wheat from 1st December, yield will be reduced at least 1% for delayed plantation of each day.

So, the overall objective is to identify the benefit/results of direct seeding technology with short duration rice variety as compared with traditional transplanted rice, which enables landless farmers/day laborers to get access to work in lean period.

The specific objectives of this study were as follows:

1. To evaluate the effect of direct seeding rice on the yield and income of rice
2. To know the effect of time of planting on the yield and income of rice
3. To find out the employment opportunity creation due to adjustment of planting time and method of rice

Materials and Methods

In 2014, a short duration rice variety (BRRI Dhan33) with three planting dates (15th June, 30th June and 15th July) under two planting methods (direct seeding and transplanting) was tested through on-station research to identify suitable time of planting in support of early harvest during lean period. The experimental plots of direct seeding under 15th July planting were damaged due to heavy rainfall occurred during mid-July. So, the experiment of 15th July planting under direct seeding condition excluded from this study.

Treatments	Treatments
1.DSS X15 June (BRRI Dhan33)	Direct Seeding System in 15th June
2.DSS X 30 June (BRRI Dhan33)	Direct Seeding System in 30th June
3.TTS X 15 June (BRRI Dhan33)	Traditional Transplanting System (15th June seed sowing)
4.TTS X 30 June (BRRI Dhan33)	Traditional Transplanting System (30th June seed sowing)
5.TTS X 15 July (BRRI Dhan33)	Traditional Transplanting System (15th July seed sowing)

In 2015, the same experiment was conducted but with a different composition of planting dates on direct seeded rice along with traditional like 1st, 15th & 30th June. In the next year, it was realized that direct seeding technology will not be appropriate in mid July due to frequent rainfall, for which, the planting dates were re-organized in 2015 as 1st, 15th and 30th June instead of 15th June, 30th June and 15th July. In addition, a traditional popular variety BR11 along with a short duration variety BRRI dhan33 was used in this experiment. The direct seeding and traditional transplanting system of both BRRI dhan33 and BR11 rice varieties were established in different dates (1st, 15th and 30th June) to investigate the comparative performance of direct seeded and conventional transplanted rice during the monsoon (*aman*) season. The experiment was laid out in a split-split plot design with 5 replications as follows:

Treatments	Descriptions
1. DSS X1st June (BRRI Dhan33)	Direct Seeding System in 1st June
2. DSS X 15 June (BRRI Dhan33)	Direct Seeding System in 15th June
3. DSS X 30 June (BRRI Dhan33)	Direct Seeding System in 30th June
4. TTS X 1st June (BRRI Dhan33)	Traditional Transplanting System (1st June seed sowing)
5. TTS X 15 June (BRRI Dhan33)	Traditional Transplanting System (15th June seed sowing)
6. TTS X 30 June (BRRI Dhan33)	Traditional Transplanting System (30th June seed sowing)

Treatments	Descriptions
7. DSS X 1st June (BR 11)	Direct Seeding System in 1st June
8. DSS X 15 June (BR 11)	Direct Seeding System in 15th June
9. DSS X 30 June (BR 11)	Direct Seeding System in 30th June
10.TTSX 1st June (BR 11)	Traditional Transplanting System (1st June seed sowing)
11. TTSX15 June (BR 11)	Traditional Transplanting System (15th June seed sowing)
12. TTSX30 June (BR 11)	Traditional Transplanting System (30th June seed sowing)

A medium high land of 300 m2 was selected in the RDRS Farm, Rangpur for this experiment. The land is sandy loam. At the beginning of the experiment, soil samples were collected to identify soil health and nutrition status. Out of 300 m2, 150 m2 was used for BRRI dhan33 and remaining 150 m2 of land used for BR11 rice variety. BRRI recommended fertilizer doses (medium) were followed in all treatments. Data were collected as: (1) Panicle per m2 (2) Filled grain per panicle (3) Empty grain per panicle (4) Plant height (5) Weight of 1000 grains (6) Crop duration (7) Pest infestation per m2 (8) Yield (9) Crop harvest dates and (10) Production cost.

Result and Discussions

Effect of planting methods on the yield and crop duration in 2014

Most of the plant characters as affected by planting methods (direct seeding and transplanting) are presented in Table 3. There was no significant effect of planting methods on the plant character. However, apparently the lower crop duration (100 days) and higher grain yield (4 t/ha) were found with direct seeding compared to 119 days crop duration and 3.8 t/ha grain yield under transplanting system.

Table 3: Effect of planting method on the yield, yield components and crop duration in 2014

Treatment	Panicle per hill (No)	Panicle per m2 (No)	Filled grain / panicle (No)	Empty Grain /panicle (No)	Plant height (cm)	1000-grains weight (gm)	Crop Duration (Day)	Pest Infestation per m2 (No)	Yield in ton / ha
DSS	10.867	426.467	123.13	34.47	100.387	24.6	100.533	3.133	4.05
TSS	10.333	325.4	148	30.13	97.267	23.733	119.6	2.8	3.86
LSD	2.18	26.40	54.05	10.58	3.85	0.88	1.30	0.80	0.28
CV%	19.93	13.91	18.84	31.69	3.76	3.52	1.14	26.18	6.76

Effect of planting time on the yield and crop duration in 2014

The experimental plots of direct seeding under 15th July planting time were damaged due to heavy rainfall occurred during mid-July. So, the experiment of 15th July planting under direct seeding is excluded from this study. However, the result of the effect of planting time on the grain yield and crop duration is presented in Table 4. There was no significant effect of planting time on number of panicle per hill, number of empty grain per panicle, plant height, 1000-grains weight and crop duration. But significantly the higher yield was observed with 30th June planting (4.12 t/ha), which was found at par with that of 15th July planting time (4.08 t/ha). The 15th June planting provided the lowest grain yield (3.67 t/ha). This poor yield of 15 June planting was attributed to the lowest panicle/m2 and filled grain/panicle but to the highest pest infestation.

Employment generation of agricultural day labourers

Interaction effect between planting methods and planting times on crop duration and grain yield in 2014

Interaction effect between planting methods and planting times were significant for crop duration and grain yield (Table 5). The 30th June planting under direct seeding performed best in all aspects over transplanting. It produced 4.24 t/ha grain yield with 100 days crop duration under direct seeded condition, whereas 4 t/ha grain yield with 119 days was recorded for 30th June seeding under transplanting. There was no significant difference in panicle per hill, empty grain per panicle and plant height due to planting time and method. The best performance of 30th June planting under direct seeding was due to significantly higher panicle (437.4/m2), filled grain/panicle (131.2), 1000 grains weight (25 gm) and lower pest infestation/m2 (3.4).

Table 4: Effect of planting time on the yield, yield components and crop duration in 2014

Treatment	Panicle per hill (No)	Panicle per m2 (No)	Filled grain /panicle (No)	Empty Grain /panicle (No)	Plant height (cm)	1000-grains weight (gm)	Crop Duration (Day)	Pest Infestation/ per m2 (No)	Yield in ton / ha
15-Jun	9.7a	341.5b	118.6b	38.1a	98.46 a	24 a	110.3 a	3.5 a	3.67b
30-Jun	11.1a	389.8ab	143.8a	29.1a	98.52 a	24.3 a	109.8 a	3 a b	4.12a
15-Jul	11a	396.5a	144.3a	29.7a	99.5 a	24.2 a	110.1 a	2.4 b	4.08a
LSD	1.971	48.78	23.83	9.547	3.471	0.7932	1.174	0.7244	0.2503
CV%	19.93	13.91	18.84	31.69	3.76	3.52	1.14	26.18	6.76

Table 5: Interaction between planting method and planting time on crop duration and grain yield in 2014

Treatment	Panicle per hill (No)	Panicle per/ m2 (No)	Filled grain/ panicle (No)	Empty Grain /panicle (No)	Plant height (cm)	1000-grains weight (gm)	Crop Duration (Days)	Pest Infestation per m2 (No)	Yield in ton / ha
DSSx15 June	10a	402.6ab	107.2b	38.2a	100.5a	24.4ab	101.2b	3.6a	3.67b
DSSx30 June	11.4a	437.4a	131.2ab	33.8a	100a	25a	100b	3.4ab	4.24a
TSSx15-June	9.4a	280.4a	130.ab	38.a	96.4a	23.6b	119.4a	3.4ab	3.67b
TSSx30-June	10.8a	342.2ba	156.4a	24.4a	97a	23.6b	119.6a	2.6ab	4ab
TSSx15-July	10.8a	353.6b	157.6a	28a	98.4a	24ab	119.8a	2.4b	3.92ab
LSD	2.787	68.98	33.70	13.50	4.909	1.122	1.660	1.024	0.3540
CV%	19.93	13.91	18.84	31.69	3.76	3.52	1.14	26.18	6.76

Effect of variety on the yield, yield components and crop duration in 2015

The effect of two varieties on the yield, yield components and crop duration was varied significantly (Table-6). BR11 produced the higher panicle number/m2 (432), higher filled grain/panicle (129), higher plant height in cm. (112), higher crop duration (138 days) and higher grain yield (4.14 t/ha). On the other hand, BRRI Dhan33 produced higher 1000-grains weight (24gm.) and lowest number of empty grain/panicle (29). There was no significant effect of pest infestation.

Effect of planting methods on the yield, yield components and crop duration

Most characters of the two planting methods on the yield and yield components were varied significantly (Table 7). Lower crop duration (116 days), higher panicle number per m2 (415) and higher grain yield (4 t/ha) were found with direct seeded rice. There was no significant effect of planting methods on plant height and 1000-grain weight. But significantly highest filled grain per panicle (130), lowest empty grain per panicle (27) and lowest pest infestation per m2 (1.96) were recorded from transplanted rice.

Table 6: Effect of variety (average over planting method and planting time) on yield, yield components and crop duration in 2015

Treatment/ Variety	Panicle/m^2 (No.)	Filled grain/panicle (No.)	Empty grain/panicle (No.)	Plant height (cm)	1000-grains weight (gm)	Crop duration (days)	Pest infestation/ m^2 (No.)	Yield in ton /ha
BR-33	340.27 b	110.16 b	29.66 b	99.86 b	24.13 a	112.1 b	2.4 b	3.71 b
BR11	432.96 a	129.86 a	33.83 a	112.56 a	22.96 b	138.7 a	2.53 a	4.14 a
LSD	25.24	16.53	12.76	2.41	1.24	0.78	0.78	0.39
CV%	7.02	14.80	31.75	1.79	4.17	0.67	34.22	10.73

Table 7: Effect of planting method (average over variety and planting method) on the yield, yield components, and crop duration in 2015

Treatment	Panicle/m^2 (No.)	Filled grain/panicle (no.)	Empty grain/panicle (No.)	Plant height (cm)	1000-grains weight (gm)	Crop duration (days)	Pest infestation/m 2 (No.)	Yield in t/ha
DSS	415.4 a	109 b	35.8 a	106.8 a	23.6 a	116.4 b	2.9 a	4 a
TSS	357.8 b	130.9 a	27.6 b	105.6 a	23.4 a	134.4 a	1.9 b	3.8 b
LSD	28.05	18.37	7.66	1.45	1.02	0.64	0.64	0.44
CV%	7.02	14.80	31.75	1.79	4.17	0.67	34.22	10.73

Effect of planting time on the yield, yield components and crop duration:

The effect of planting time on the yield and yield components are presented in Table 8. There was no significant effect of planting time on plant height and weight of 1000 grains. But the panicle per m2, filled grain/panicle and grain yield were significantly higher with 15th and 30th June planting as compared with those of 1st June planting time, while no significant differences in these components was observed between 15th & 30th June planting time. Lowest crop duration (123) and lowest number of pest infestation per m2 (1.45) were recorded from 30th June planting time, which are significantly different from 1st & 15th June planting.

Interaction effect between varieties and planting methods on crop duration and grain yield

Interaction effect between planting methods and varieties were significant for panicle per m2, crop duration, pest infestation per m2 and grain yield (Table-9). BR11 performed in all aspects under direct seeding condition over transplanting. It produced 4.19 t/ha grain yield with 129 days crop duration under direct seeding condition and 4 t/ha grain yield with 148 days crop duration under transplanting system. BRRI Dhan33 showed significantly better performance with lowest crop duration (103 days) and ensured 3.8 t/ha grain yield over transplanting system of 120 days crop duration and 3.6 t/ha grain yield.

Interaction effect between varieties and planting time on crop duration and grain yield

All the plant characters varied significantly due to interaction effect between planting time and varieties (Table-10). BR11 produced significantly the higher grain yield with 15th June seeding due to significantly higher panicle per m2 (447.9) and lower crop duration (138 days). Under different dates of BRRI Dhan33 plantings, the highest grain yield was 4 t/ha within 109 days crop duration through 30th June planting time. Significantly higher grain yield

was observed with BR11 in 15th June (4.34 t/ha) and 30th June (4.33 t/ha) planting and BRRI Dhan33 in 30th June (4 t/ha) planting. This performance of BR11 in 15th June and 30th June planting was due to higher filled grain/panicle (134.6 no. and 136.5 no. respectively) and panicle/m2 (447.9 no. and 449.8 no. respectively), while the performance of BRRI Dhan33 was due mainly to filled grain/panicle (120 no.) and 1000 grains weight (24.3 gm.).

Table 8: Effect of planting time (average over variety and planting method) on the yield, yield components and crop duration in 2015

Treatments	Panicle/m2 (No.)	Filled grain/panicle (No.)	Empty grain/panicle (No.)	Plant height (cm)	1000-grains weight (gm)	Crop duration (days)	Pest infestation/m2	Yield in ton /ha
1st June	352.30 b	108.75 b	36.40 a	105.55 a	23.40 a	127.45 a	3.65 a	3.5 b
15 June	401.10 a	123.05 a	31.25 ab	106.40 a	23.65 a	125.25 b	2.3 b	4.116 a
30-Jun	406.45 a	128.25 a	27.60 b	106.70 a	23.60 a	123.65 c	1.45 c	4.167 a
LSD	17.48	11.44	6.493	1,228	0.6334	0.5389	0.5435	0.2718
CV%	7.02	14.80	31.75	1.79	4.17	0.67	34.22	10.73

Table 9: Interaction effect between variety and planting method (average over sowing time) on yield, yield components and crop duration in 2015

Treatment	Panicle/m2 (No.)	Filled grain/panicle (No.)	Empty grain/panicle (No.)	Plant height (cm)	1000-grains weight (gm)	Crop duration (days)	Pest infestation/m2 (No.)	Yield in t/ha
BRRI33 X DSS	388.13 b	97.667	34	100.4	24.333	103.733	2.533	3.821
BRRI33 X TSS	292.40 c	122.667	25.333	99.333	23.933	120.533	2.267	3.611
BR11 X DSS	442.70 a	120.467	37.667	113.2	22.933	129.133	3.4	4.191
BR11 X TSS	423.2 ab	139.267	30	111.933	23	148.267	1.667	4.088
LSD	44.26	12.42	6.947	2.835	0.6066	0.7464	0.7634	0.2002
CV%	7.02	14.80	31.75	1.79	4.17	0.67	34.22	10.73

Interaction effect between planting time and planting method on crop duration and grain yield

Interaction effect between planting time and planting methods was significant on crop duration and grain yield (Table-11). Direct seeding with 30th June planting provided significantly the highest number of panicle per m2 (438) and highest grain yield (4.3 t/ha) within lowest crop duration (114 days). Under transplanting system, 15th and 30th June performed significantly higher in grain yield (3.9

t/ha and 4 t/ha respectively). The difference in grain yield between this 15th and 30th June was found statistically insignificant. The higher grain yield was obtained with 15th and 30th June under transplanting system (3.98 t/ha) and 4.01 t/ha respectively) and also with 30th June under direct seeding (4.32 t/ha). No difference in grain yield was observed between 15th and 30th June under transplanting. This performance of transplanting with 15th and 30th June was mainly due to higher filled grain/panicle and lower pest infestation, while with direct seeding of 30th June was mainly due to higher panicle/m2, filled grain/panicle and plant height.

Table 10: Interaction between variety and planting time (average over planting method) on yield, yield components and crop duration in 2015

Treatments	Panicle/m2 (No.)	Filled grain/panicle (No.)	Empty grain/panicle (No.)	Plant height (cm)	1000- grains weight (gm)	Crop duration (days)	Pest infestation/m2 (No.)	Yield in ton /ha
BR33X1June	303.40 d	99 d	32.5 ab	99.1 b	23.8 ab	114.5 c	3.5 a	3.26 c
BR33X15 June	354.30 c	111.5 cd	32.5 ab	100.2 b	24.3 a	112.3 d	2.6 b	3.884 b
BR 33X30 June	363.10 c	120 abc	24.0 b	100.3 b	24.3 a	109.2 e	1.1 c	4.003 ab
BR11X1 June	400.20 b	118.5 bc	40.3 a	112 a	23 b	140 a	3.8 a	3.74 b
BR11X15 June	447.90 a	134.6 ab	30 b	112.6 a	23.6 b	138 b	2.0 b	4.348 a
BR11 X30 June	449.80 a	136.5 a	31.2 ab	113.1 a	22.9 b	138.1 b	1.8 bc	4.331 a
LSD	24.72	16.18	9.182	1.736	0.8958	0.7622	0.7687	0.3843
CV%	7.02	14.80	31.75	1.79	4.17	0.67	34.22	10.73

Table 11: Interaction between planting method and planting time (average over variety) on yield, yield components and crop duration in 2015

Treatments	Panicle/m2 (No.)	Filled grain/panicle (No.)	Empty grain/panicle (No.)	Plant height (cm)	1000-grains weight (gm)	Crop duration (days)	Pest infestation/m2 (No.)	Yield in ton /ha
DSS X 1 June	375.4 b	96 c	42.5 a	106 ab	23.6 a	118.5 d	3.9 a	3.448 b
DSS X15 June	432.5 a	111.6 bc	34.9 ab	107.2 a	23.7 a	116.4 e	3 b	4.248 a
DSSX 30 June	438 .4 a	119.6 ab	30.1 b	107.2 a	23.6 a	114.4 f	2 c	4.322 a
TSS X1 June	329.2 c	121.5 ab	30.3 b	105.1 b	23.2 a	136.4 a	3.4 ab	3.552 b
TSSX15 June	369.7 b	134.5 a	27.6 b	105.6 ab	23.6 a	133.9 b	1.6 cd	3.984 a
TSSX30 June	374.5 b	136.9 a	25.1 b	106.2 ab	23.6 a	132.9 c	0.9 d	4.012 a
LSD	24.72	16.18	9.182	1.736	0.8958	0.7622	0.7687	0.3843
CV%	7.02	14.80	31.75	1.79	4.17	0.67	34.22	10.73

Employment generation of agricultural day labourers

Integration effect between variety, planting method and planting time as crop duration and grain yield

Interaction effects between variety, planting method and planting time was significant on crop duration and grain yield (Table-12). Under direct seeding condition, BR11 produced highest yield within 128 days crop duration from 15th & 30th June under direct seeding (4.49 t/ha and 4.50 t/ha respectively). Under transplanting system, highest grain yield recorded by BR11 was 4.2 t/ha with 15th June planting. Side by side, BRRI Dhan33 produced 4.1 t/ha grain yield under direct seeding on 30th June within 100 days crop duration, which are found at par with that under direct seeding on 15th June (4 t/ha). Significantly the highest yield (4.5 t/ha) was obtained with BR11 direct seeding on 30th June, which is at par with that of BR11 direct seeding on 15th June (4.49 t/ha), BRRI Dhan33 direct seeding 15th June (4 t/ha) and 30th June (4.14 t/ha), BR11 transplanting 1st June seeding (3.90 t/ha), 15th June (4.2 t/ha) and 30th June seeding (4.16 t/ha). This performance of BR11 and BRRI Dhan33 under direct seeding on 15th June and 30th June respectively was due to higher filled grain/panicle and panicle/m2 of BR11 and higher 1000 grains weight, lower empty grain/panicle and lower pest infestation of BRRI Dhan33.

Table 12: Interaction effect between variety, planting method and planting time on the yield, yield components and crop duration in 2015

Treatment	Panicle/m2 (No.)	Filled grain/panicle (No.)	Empty grain/panicle (No.)	Plant height (cm)	1000-grains weight (gm)	Crop duration (days)	Pest infestation/ m2 (No.)	Yield in ton /ha
BR 33 X DSS X 1st June	355 c	84 d	39 ab	99.6 b	24.2 ab	107 h	3.6 ab	3.32 cd
BR 33 X DSS X .15 June	400.8 b	100 cd	37 abc	101 b	24.4 a	104.2 i	2.8 b	4 ab
BR 33 X DSS X .30 June	408.6 b	109 bc	26 bc	100.6 b	24.4 a	100 j	1.2 c	4.142 ab
BR 33 X TSS X 1st June	251.8 e	114 bc	26 bc	98.6 b	23.4 ab	122.8 e	3.4 ab	3.2 d
BR 33 X TSS X .15 June	307.8 d	123 abc	28 bc	99.4 b	24.2 ab	120.4 f	2.4 b	3.768 bcd
BR 33 X TSS X .30 June	317 .6 d	131 ab	22 c	100 b	24.2 ab	118.4 g	1 c	3.864 bc
BR 11 X DSS X 1st June	395.8 b	108 bcd	46 a	112.4 a	23 ab	130 c	4.2 a	3.576 bcd
BR 11 X DSS X 15 June	464.2 a	123.2 abc	32.8 abc	113.4 a	23 ab	128.6 d	3.2 ab	4.496 a
BR 11 X DSS X .30 June	468.2 a	130.2 ab	34.2 abc	113.8 a	22.8 b	128.8 d	2.8 b	4.502 a
BR 11 X TSS X 1st June	406.6 b	129 ab	34.6 abc	111.6 a	23 ab	150 a	3.4 ab	3.904 abc
BR 11 X TSS X .15 June	431.6 ab	146 a	27.2 bc	111.8 a	23 ab	147.4 b	0.8 c	4.2 ab
BR 11 X TSS X .30 June	431.4 ab	142.8 a	28.2 bc	112.4 a	23 ab	147.4 b	0.8 c	4.16 ab
LSD	34.95	22.89	12.99	2.455	1.267	1.078	1.087	0.5435
CV%	7.02	14.80	31.75	1.79	4.17	0.67	34.22	10.73

Considering the yield, crop duration and harvest in October to early November (lean period), BRRI Dhan33 direct seeding on late June, BR11 direct seeding on mid June and BRRI Dhan33 transplanting on mid June (with a little sacrifice for grain yield) could be followed to create both employment opportunity for agricultural day-laborers and food production during lean period.

Analysis of labour employment in direct seeded rice over transplanted rice

Total day labourers required in transplanted rice (from seeding to storing) were 191/ha, which was found almost similar to direct seeded rice (186/ha) as shown in Table-13. It was observed that under transplanting system, the labour requirement was higher in seedbed preparation & maintenance, seedlings up-rooting and transplanting, where as the labour for laddering, manual weeding and irrigation was higher in direct seeding by drum seeder. If herbicide is used in both cases, then it is assumed that the labor employment in transplanting system will be significantly higher compared to drum seeding.

Table 13: Analysis of labour employment in direct seeding by drum seeder over transplanting system in one hectare of land

Sl. No.	Particulars	Transplanting	Direct seeding	Remarks
1	Seed-bed preparation, seed sowing and maintenance	10	0	No seedlings raising required in direct seeding.
2	Seedlings up-rooting & transplanting	30	0	No transplanting required in direct seeding
3	Boundary of main land preparation & drain making including organic & basal fertilizer Use &laddering	10	12	
4	Ploughing (Power tiller) 5 times	10	10	
5	Seed sowing by drum seeder	0	10	
6	1st weeding (manually)	30	45	Direct seeding enhances more weeds than transplanting
7	2nd weeding (manually)	20	25	Same
8	3rd weeding (manually)	15	15	
9	Irrigation	4	7	Direct seeding requires more irrigation (in number; not volume) than transplanting.
10	Pesticide spray	2	2	
11	Harvesting	15	15	
12	Bunch & carrying the harvested rice in threshing point and threshing	38	38	
13	Drying & Cleaning	5	5	
14	Storing	2	2	
	Total	191	186	

The overall results indicates that the yield of BR11 and BRRI Dhan33 rice variety was increased at least by 7% and 8% respectively under direct seeding system. Several studies have proved the efficacy of direct seeded rice in many parts of rice growing countries in the world. Ding

et al. (1999) reported that direct seeding rice gave about 15% higher grain yield over the transplanted rice in China. In Bangladesh, direct seeding rice produced about 12% higher grain yield than transplanted rice (Husain et al., 2003). The yield of direct seeding rice was higher than transplanting system because of higher plant population and thus more grain in a specific area. In this research, BR11 and BRRI Dhan33 under direct seeding condition provided 302 and 280 Kg more grain yield/ha. Sattar and Khan (1995) reported that an average yield benefit of 319 Kg/ha was obtained in direct seeded rice over the transplanting system.

The sensitivity analysis indicates a huge potential of BRRI dhan33 as a future model to replicate in a wider farming community of affected areas in northwest Bangladesh covering 107,000 hectares of land and thereby creating employment of 124,150 laborers (about one-fourth of the total affected households) for 30 days.

Conclusion

To overcome the lean period, farmers can cultivate short duration rice either direct seeding or transplanting, where farmers will get rice and day-laborers will get job to harvest rice. Also farmers can cultivate BR11 under direct seeding condition in mid-June, which may allows farmers to harvest rice in late October (lean period) with ensuring 4.5 t/ha grain yield. Per hectare of land, around 60 day laborers requires both under transplanting and direct seeding condition will get job in lean period for harvesting of rice, threshing, drying and storing, where total laborers required 186 under drum seeding condition and 191 laborers required under transplanting condition. The crop duration of both varieties (BRRI Dhan33 and BR11) were decreased around 18 days due to direct seeding system. It may be concluded that short duration variety like BRRI Dhan33 could be cultivated under direct seeding condition by late June that will bring harvesting of rice in lean period (i.e. late September to early October). It is also recommended that short duration rice may be cultivated in 3rd week of June under transplanting system (seeds to be sown in 3rd week of June and transplant the seedlings by 20 to 25 days of seedlings), which enable farmers to harvest rice by mid October to late October, i.e. also in lean period.

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