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Effect of Laser Land Levelling and Establishment Methods on Economics and Water Productivity of Rice

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ABSTRACT

Water is a key factor in boosting agricultural production, and its scarcity has prompted the development of a variety of innovative and effective water management systems.The present study has been undertaken at Regional Agricultural Research Station, Jagtialduring *rabi* season, 2020-2021 to assess the impact of laser land levelling and establishment methods on economics and water productivity of rice. The highest gross returns (Rs. 87735 ha^{-1}), net returns (Rs 49540 ha^{-1}), B:C ratio (2.25) and water productivity (0.47 kg m^{-3}) was recorded under laser land leveling and was significantly superior over conventional land leveling and control (unleveled). Among establishment methods higher gross returns (Rs 107616 ha^{-1}), net returns (Rs 64083 ha^{-1}) and water productivity (0.52 kg m^{-3}) was observed with conventional transplanting and were significantly superior to machine transplanting, wet direct seeding and semi dry rice. While, higher B:C ratio was observed with conventional transplanting (2.47).

Keywords Laser land leveling, Machine transplanting, Direct seeded rice, Water productivity.

INTRODUCTION

Farmers and agricultural researchers have made many types of initiatives to boost crop output from time to time. Increased agricultural crop productivity, as well as conservation of natural resources, such as water conservation and limited use of fertilizers and pesticides, are required for sustainable agriculture. India would need more 37% wheat and rice by 2025 with less irrigation availability from 9% to 7% (Jat *et al.* 2006). Shrinking water resources owing to over exploitation of ground water threatens the maintenance of agricultural productivity. As a result, the water table is falling. To arrest this dangerous trend of ground water exploitation, there is anurgent need to conserve irrigation water through various farm water conservation practices. Land leveling through laser levelers is one such proven technology that is highly useful in conservation of irrigation water.Laser land levelling saves 15-30 % of water under various

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crops and cropping patterns (Eid *et al.* 2014). It results in 3 to 4% additional land recovery and improves operational efficiency i.e., reducing operating time by 10 - 15% leads to reduced consumption of seeds, fertilizers, chemicals and fuel.

Traditional way of rice transplanting is labour intensive and involves drudgery. Scarcity of irrigation water and shortage of farm laborers trigger the search for such alternative rice crop establishment methods having high water productivity than conventional puddled transplanting. Direct seeded rice is one of the option available for rice crop establishment having high water productivity and proven to reduce methane emissions due to shorter flooding and decreased soil disturbance compared to transplanting of rice seedlings (Kumar *et al.* 2018). Similarly,Machine transplanting of rice is cost effective and operation friendly. It helps in maintaining soil physical properties with better crop management and productivity.

MATERIALS AND METHODS

A field experiment was carried out at Regional Agricultural Research Station, Jagtial under Professor Jayashankar Telangana State Agricultural University, Hyderabad during *Rabi* 2020-21. The experimental area is located at Polasa, Jagtial with an altitude of 234.4 m above mean sea level (MSL) at 18^{o}49'40" N latitude and 78^{o}56'45"E. The composite soil of experimental site is clay loam in texture, low in available N 195 kg ha^{-1}, high in available P 46 kg ha^{-1} and available K 354 kg ha^{-1} with neutral in reaction (pH 7.24) and electrical conductivity 0.24 ds/m.

The experiment was laid out in a strip plot design with 12 treatments comprising of three land levelling methods viz., laser land leveling, conventional and un leveled with four establishment methods viz. semi dry rice, wet direct seeding, conventional transplanting and machine transplanting replicated thrice. The experiment was initially dry ploughed with tractor drawn mould board plough followed by cultivator and rotavator operations to get fine tilth. Later, as per the main treatments i.e. laser land leveling , conventional land leveling the land was leveled with laser guided leveler, with jumbo drawn cultivator respectively and no leveling operation performed in control (Unlevelled) plot. Then water was let into the field for puddling with rotavator separately for eachmain plot treatment with sub plots of wet direct seeding, conventional transplanting and machine transplanting and field was remain un puddled for semi dry rice. Later the field was laid into plots providing with irrigation channels. Under establishment methods in case of semi dry rice the dry seeds @ 75 kg ha^{-1} were sown in solid rows directly in the soil under un puddled condition. The spouted seeds (75 kgha^{-1}) were sown in solid rows under puddled condition in main filed under wet direct seeding. In conventional transplanting the sprouted seeds (65 kg ha^{-1}) were broadcasted uniformly in a well prepared and levelled raised seed bed. The seedlings were maintained for period of 25 days in nursery and then transplanted in the puddled main field. Under machine transplanting the sprouted seeds were broadcasted uniformly on each tray which already filled with wellprepared soil approximately @ 140 g per tray then covered with thin layer of soil and sprinkled water regularly upto six days then trays were shifted to field nursery bed where water was applied through channel till transplanting. During transplanting (15 days old seedlings), the mats were lifted from the trays and placed directly in the seedling channel of transplanter and transplanting done with machine transplanter by running length wise inpuddle field. All recommended package of practices done pertaining to other management practices.

RESULTS AND DISCUSSION

Yield

Laser land levelling registered significantly higher grain (4697 kg ha^{-1}) and straw yield (3628 kg ha^{-1}) followed by conventional land leveling and un levelled treatment (Table 1). Levelling in field plays an important role in even distribution of soil moisture throughout the crop period that enhances the uniform establishment, crop growth and ultimately the yield (Ashraf *et al.* 2017). Among establishment methods, significantly higher grain (5761 kg ha^{-1}) and straw yield (4436 kg ha^{-1}) were registered with conventional transplanting followed by machine transplanting and wet direct seeding. While, significantly lowest grain and straw yield were registered with semi dry rice. Higher grain yield under puddling condition could

Table 1. Grain yield, straw yield of rice as influenced by land levelling and establishment methods.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Land levelling practices (M)		
Laser levelling	4697	3628
Conventional leveling	3968	3157
Un levelled	3780	3066
SEm±	102	76
CD (p=0.05)	400	300
Establishment methods (S)		
Semi dry rice	2470	1936
Wet direct seeding	3265	2652
Conventional transplanting	5761	4436
Machine transplanting	5097	4112
SEm±	78	75
CD (p=0.05)	190	259
Interactions (M × S)		
Factor (B) at same level of A		
SEm±	152	103
CD (p=0.05)	NS	NS
Factor (A) at same level of B		
SEm±	167	118
CD (p=0.05)	NS	NS

be due to proper plant spacing, which ensures improved air circulation, water and light, all of which are essential for photosynthesis (Baloch *et al.* 2002).

Economics

Rice profitability increased dramatically as a result of laser land leveling. The highest gross returns (87735 Rs ha^{-1}), net returns (49540 Rs ha^{-1}) and B:C ratio (2.25) was recorded from laser land leveling and was significantly superior to conventional land leveling and unleveled field (Table 3).The per cent increase in gross returns with laser land leveling over conventional land levelling and unleveled field was 15% and 24% respectively. These increased returns might be due to increased yield per unit area. The results are in line with the findings of Abdullaev *et al.* (2007) ,Ashraf *et al*. (2017).

Gross returns, net returns and B:C ratio of rice obtained from different land leveling practices were differed significantly. The highest gross returns

Table 2. Economics of rice influenced by land levelling practices and establishment methods.

Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
Land leveling practices (M)				
Laser levelling	38195	87735	49540	2.25
Conventional leveling	37495	74117	36622	1.93
Un levelled	36695	70611	33916	1.87
SEm±		1902	1902	0.04
CD (p=0.05)		7467	7467	0.19
Establishment methods (S)				
Semi dry rice	31508	46149	14641	1.46
Wet direct seeding	35508	60981	25473	1.71
Conventional transplanting	43533	107616	64083	2.47
Machine transplanting	39298	95205	55907	2.42
SEm±		1024	1024	0.02
CD (p=0.05)		3545	3545	0.09
Interactions (M × S)				
Factor (B) at same level of A				
S.Em±		2844	2844	0.07
CD (p=0.05)		NS	NS	NS
Factor (A) at same level of B				
SEm±		3112	3112	0.07
CD (p=0.05)		NS	NS	NS

(107616 Rs ha^{-1}) and net returns (64083 Rs ha^{-1}) were observed with conventional transplanting and was significantly superior to semi dry rice, wet direct seeding and machine transplanting. While, higher B:C ratio was observed with conventional transplanting (2.47) which was comparable with machine transplanting (2.42) and significantly superior to semi dry rice (1.46), wet direct seeding (1.71).The per cent increase in gross returns with conventional transplanting over semi dry rice, wet direct seeding and machine transplanting was 57 %, 43% and 11 % respectively.

Higher cost of cultivation in manual transplanting was mainly because of more labor for transplanting coupled with high wages. The lowest cost of cultivation was incurred in semi dry rice due to less labor force requirement and minimum preparation of field as compared to transplanting of rice (Poudel *et al.* 2021).

Table 3. Irrigation water applied (mm) and water productivity (kg m^{-3}) of rice influenced by land levelling practices and establishment methods.

Treatments	Water applied (mm)	Water productivity (kg m^{-3})
Land leveling practices (M)		
Laser levelling	980	0.47
Conventional leveling	1060	0.37
Un levelled	1140	0.33
SEm±		0.009
CD (p=0.05)		0.04
Establishment methods (S)		
Semi dry rice	920	0.27
Wet direct seeding	1080	0.31
Conventional transplanting	1120	0.52
Machine transplanting	1120	0.46
SEm±		0.005
CD (p=0.05)		0.02
Interactions (M x S)		
Factor (B) at same level of A		
SEm±		0.01
CD (p=0.05)		NS
Factor (A) at same level of B		
SEm±		0.01
CD (p=0.05)		NS

In spite of the fact that, manual transplanting is cumbersome practice and requires more labor. The inadequacy of scarce labor coupled with higher wages during the peak period of farm operations, invariably led to delay in transplanting. Machine transplanting is an alternate crop establishment method to conventional manual transplanting, as it saves labor, ensures timely transplanting and attains optimum plant population to increasing the productivity and profitability (Nagabhushanam and Bhatt 2020).

Applied water in each treatment (mm)

Precision land leveling significantly reduced the amount of water application to the field (Table 3). Maximum amount of water was applied in unlevelled treatment (1140 mm) among different land levelling methods and was significantly superior to conventional land levelling (1060 mm) and the lowest amount of water applied in laser leveled treatment (980 mm). As the precisely levelled and smooth field with laser guided leveler showed a positive impact on the total water use resulting in a tangible reduction. The results are in conformity with the findings of Tomar *et al.* (2020), Das *et al.* (2018).

Among establishment methods, maximum amount of water was applied in conventional transplanting (1120 mm) and machine transplanting method (1120 mm) and were significantly superior to wet direct seeding (1080 mm) and semi dry rice (920 mm). Higher water use in transplanted fields is due to additional irrigation water required for puddling and to meet natural field losses such as seepage and deep percolation (Soriano *et al.* 2018).

Water productivity (kg m^{-3})

Significantly higher water productivity was observed with laser land levelling (0.47 kg m^{-3}) compared to conventional land leveling (0.37 kg m^{-3}) and unlevelled treatment (0.33) kg m^{-3} which in turn, recorded the lowest water productivity.The improved water productivity under laser levelling might be due to improved application and distribution efficiencies of applied water compared to traditional leveling as reported earlier by Sattar *et al.* (2003), Rajput *et al.* (2003). Among establishment methods significantly higher water productivity was observed with conventional transplanting (0.52 kg m^{-3}) followed by machine transplanting (0.46 kg m^{-3}) and wet direct seeding (0.31 kg m^{-3}) whereas the lowest was observed with semi dry rice (0.27 kg m^{-3}). The higher water productivity under conventional transplanting might be attributed due to higher yield.

CONCLUSION

Based on the results obtained from the present investigation, it is concluded that cultivation of rice under laser leveled field with conventional transplanting was found to be economical with yield, net returns, B:C ratio and water productivity. Under inadequacy of labor coupled with higher wages situation, machine transplanting of rice was found to be economical method of establishment.

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