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Productivity and profitability in dry direct sown rice through mechanization

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Abstract
In most of South Asia, common practice of establishing rice cultivation is through puddling followed by manual transplanting. Direct seeding methods have several advantages over transplanting. Firstly, direct seeding saves labour. Farm mechanization is low in the rice crop in India. Complete machinery package is needed to be introduced to enhance the production and also it helps in minimize the input energy and cost involved in rice crop. The development of short duration, early-maturing cultivars and efficient nutrient management techniques along with increased adoption of integrated weed management methods have encouraged many farmers to switch from transplanted to DSR culture. Area under direct sown rice is increasing every year under North coastal Zone as the farmers are switching over from lowland rice cultivation. The causes for such a change over in the method of cultivation is due to the late release of irrigation water in the canals, erratic rainfall pattern and the shortage of labour for transplanting rice. However, the yields of paddy in this situation will be greatly limited by labour costs and lack of proper weed management which needs to be effectively managed for realizing higher productivity. Rice under direct sown conditions has great potential for realization of higher grain yields. However, severe weed infestation has been recognized as one of the major limitations that hamper the enhanced productivity levels in rice grown under this system. Therefore, the present investigation is proposed to study the mechanization in DSR in combination with efficacy of the available pre and post emergence herbicides for efficient and economical weed control. Dry direct seeding (DDS) with total mechanization (Sowing with seed drill, pre-emergence spray of Pretilachlor@500 ml/ac+ post emergence spray of bispyribacsodium@100 ml/ac, power weeding, mechanical harvesting and threshing / Winnowing fan, seed processing) recorded an average grain yield of 6467 $kgha^{-1}$ with an increase of 28.37% when compared to farmers practice(5269 $kgha^{-1}$). Similarly the straw yield is also recorded 16.95% high in mechanized practice (6410$kgha^{-1}$) with that of farmers practice(5690 $kgha^{-1}$). The total cost of cultivation was reduced to 15.78% in mechanized practice and gross income was increased by 17.12% in comparison with farmers practice. The benefit cost ratio(2.87) is also more in mechanized practice in comparing with farmers practice(2.11).

Keywords: Dry direct sown rice (DDS), mechanization, seed drill, productive tillers, yield and economics

Introduction
In most of South Asia, common practice of establishing rice cultivation is through puddling followed by manual transplanting. Although puddling helps in reducing water losses through percolation and controlling weeds by submergence of rice fields, besides being costly, cumbersome and time consuming, it results in degradation of soil and other natural resources. Deterioration of soil structure, reduced soil aggregates stability and development of hard pan at a depth of 10-40 cm, increase in bulk density and soil compaction (Balloli *et al*., 2000), labor scarcity and drudgery among women workers (Budhar and Tamilselvan, 2001) are some of the other disadvantages associated with puddle transplant rice. Under such situations, intervention in the form of mechanized transplanting or direct seeding of rice is the need of time to avoid puddling or manual transplanting or both. Direct seeding of rice has already been reported remunerative and cultivation of direct seeded rice (DSR) has already been recommended for farmers in Punjab (Malik and Yadav, 2008). Direct seeding methods have several advantages over transplanting, firstly, direct seeding saves on labour. Depending on the nature of the production system, direct seeding can reduce the labour requirement by as much as 50%. Second, in situations where no substantial reduction in labour requirement occurs, direct seeding can still be beneficial because the demand for labour is spread out over a longer

time than with transplanting, which needs to be completed within a short time. Direct seeding can also reduce the risk by avoiding terminal drought that lowers the yield of transplanted rice, especially if the later is established late due to delayed rainfall.

Farm mechanization is low in the rice crop in India. However, it has been picking up and many of the small and big farm-machineries are now a common sight in India. Even combined harvester is also being used to harvest rice crop in many parts of India. Over these years there was rapid shift in farm power uses from animal power to mechanical power. Mechanical power helps in timely farm operations with less labour and cost, but reduction in animal use on farms. Complete machinery package is needed to be introduced to enhance the production and also it helps in minimize the input energy and cost involved in rice crop. The use of machinery for field preparation operation for rice cultivation is high and most of the farmers of India are using tractor with matching implements for deep ploughing and puddling operation.

In India, the availability of draught animals power has come down from 0.133 kW ha^{-1} in 1971-72 to 0.094 kW ha^{-1} in 2012-13, whereas, the share of tractors, power tillers, diesel engines and electric motors has increased from 0.020 to 0.844, 0.001 to 0.015, 0.053 to 0.300 and0.041 to 0.494 kW ha^{-1}, respectively during the same period. The rice transplanters market in India has grown from about 550 in 2008-09 to 1,500-1,600 units in 2013-14. The industry is expected to grow by more than 50% in 2014-15 with Chhattisgarh, Odisha, Bihar and southern states showing positive sign of adoption of technology (Mehta *et al*. 2014).

According to Ektha Joshi *et al*. (2013), direct seeded rice (DSR) technique is becoming popular nowadays because of its low-input demanding nature. The development of short duration, early-maturing cultivars and efficient nutrient management techniques along with increased adoption of integrated weed management methods have encouraged many farmers to switch from transplanted to DSR culture. This technology is highly mechanized in some developed nations like U.S, Europe and Australia. This shift should substantially reduce crop water requirements and emission of greenhouse gases. The reduced emission of these gases helps in climate change adaptation and mitigation, enhanced nutrient relations, organic matter turnovers, carbon sequestration and also provides the opportunity of crop intensification.

Area under direct sown rice is increasing every year under North coastal Zone as the farmers are switching over from lowland rice cultivation. The causes for such a change over in the method of cultivation is due to the late release of irrigation water in the canals, erratic rainfall pattern and the shortage of labour for transplanting rice. However, the yields of paddy in this situation will be greatly limited by labour and lack of proper weed management which needs to be effectively managed for realizing higher productivity

Rice under direct sown conditions has great potential for realization of higher grain yields. However, severe weed infestation has been recognized as one of the major limitations that hamper the enhanced productivity levels in rice grown under this system. Earlier experiences elsewhere have shown that screening of both pre emergence and post emergence herbicides of low volume enhances efficiency in weed control.

Therefore, the present investigation is proposed to study the mechanization in DSR in combination with efficacy of the available pre and post emergence herbicides for efficient and economical weed control

Objectives

1. To study the effect of different types of mechanisation on growth and yield of dry direct sown rice
2. To study the effect of different types of weed management practices on performance of dry direct sown rice
3. To work out the interaction and economics of both the management systems on productivity of dry direct sown rice.

Materials and Methods

A field experiment was conducted at the Regional Agricultural Research Station, Anakapalle, Visakhapatnam of Acharya N.G. Ranga Agricultural University (ANGRAU), in the North - Coastal Agro-Climatic Zone of Andhra Pradesh. The experiment was laid with two treatments vize., T_1- Dry direct seeding (DDS) with total mechanization (Sowing with seed drill, pre-emergence spray of Pretilachlor@500 ml/ac+ post emergence spray of bispyribacsodium@100 ml/ac, power weeding, mechanical harvesting and threshing /combined harvester/ Winnowing fan, seed processing) and T_2- Farmers practice (Broadcasting of rice and no weedicide and manual operations for crop management in Field scale trial (T-test), in an area of 1000 m^2 each, with recommended dose of fertilizers 120-60-50 kg/ha NPK and sown during June-July, 2017, 2018 and 2019 and harvested during Nov-Dec, 2017, 2018 and 2019.

Direct seeding of Rice with Ferti Cum Seed Drill (Fig.1&2) is big equipment for sowing dry paddy seed directly in well prepared dryland field is fabricated and it is used for demonstration. There is no need for transplantation. It is a tractor drawn implement. It covers 8 rows of 20cm row-to-row spacing at a time. It is made up of iron and plastic materials.

Fig 1: Tractor Drawn Ferti Cum Seed drill

Fig. 2: Demonstration with Tractor Drawn Ferti Cum Seed drill

Salient features of direct sowing with fertile cum seed Drill

- Labour cost is reduced drastically
- Cost of cultivation is reduced because, cost on nursery raising, nursery pulling and transplanting can be saved
- Uniformity in seed sowing and Plant population
- Reduction in seed rate and thinning cost. Crop matures 7-10 days earlier than the transplanted paddy Light in weight and easy to handle
- An area of 3-4 hectare per day can be shown

Data is collected on yield attributes, yield of rice and economics in different treatments. Results were analyzed by using mean and t test and presented in tables.

Results and Discussion

Yield Attributes: The yield attributes *viz.*, total tillers per sq.mt and productive tillers per sq.mt were significantly higher in mechanized practice in comparison with farmers practice (Table 1). The parameters *viz*., panicle length, plant height, no. of grains per panicle and 1000 grain weight didn't differ significantly in both the practices. The total tillers per square meter were 12.92% more in mechanized practice (354) when compared to farmers practice (312). The productive tillers recorded 13.54% more in mechanized practice (231) with that of farmers practice (187). More number of productive tillers in direct sown rice in favorable conditions may be attributed to lack of transplanting shock to rice plants resulted in production of more number of productive tillers. Similar, results were also reported by Veeresh *et al*. (2011).

Table 1: Summarized yield attributes three *kharif* seasons *viz*., 2017, 2018 and 2019

Sl. No.	Parameter	T_1-Mechanized practice	T_2- Farmers practice	Percentage increase	t values
1	Total Tillers per Sq. m	354	312	12.92	2.36
2	Productive tillers per Sq. m	231	187	13.54	1.81
3	Panicle length(cm)	26.06	25.16	3.58	NS
4	Plant height(cm)	93.4	95.2	-1.8	NS
5	No. of grains per panicle	118	113	1.54	NS
6	1000 grain wt.(gm)	21.14	21.06	0.02	NS

Grain and straw yield

Dry direct seeding (DDS) with total mechanization (Sowing with seed drill, pre-emergence spray of Pretilachlor@500 ml/ac+ post emergence spray of bispyribacsodium@100 ml/ac, power weeding, mechanical harvesting and threshing / Winnowing fan, seed processing) recorded significantly higher grain yield of 6467 $kgha^{-1}$ (Table 2) with an increase of 28.37% when compared to farmers practice(5269 $kgha^{-1}$). Similarly the straw yield is also recorded 16.95% significantly higher in mechanized practice (6410$kgha^{-1}$) with that of farmer practice (5690 $kgha^{-1}$). The yield attributes *viz.*, productive tillers, panicle length, no. of grains per panicle and 1000 grain weight were recorded more in direct sown rice may helped in recording more grain yield in direct sown rice. The results were corroborative with Paladugu *et al*.,2004 and Gupta *et al*., 2006.

Economics

The total cost of cultivation was reduced to 15.78% in mechanized practice and gross income was increased by 17.12% in comparison with farmers practice (Table 2). The benefit cost ratio (2.87) is also more in mechanized practice in comparing with farmers practice (2.11). Due to reduction of number of labor, the cost of cultivation reduced in direct sown rice. Similar results were also reported by Singh *et al*. (2008).

Table 2: Summarized yields and economics of rice of three *kharif* seasons *viz*., 2017, 2018 and 2019

Sl. No.	Parameter	T_1-Mechanized practice	T_2- Farmers practice	Percentage increase	t values
1	Grain Yield $kgha^{-1}$	4815	4105	18.47	2.35
2	Straw Yield $kgha^{-1}$	6410	5690	16.95	2.45
3	Grain Value (Rs.14/kg)	86670	73890	-	-
4	Straw Value (Rs.0.5/kg)	3205	2845	-	-
5	Gross income $Rs.ha^{-1}$	89875	76735	17.12	-
6	Total cost of cultivation $Rs.ha^{-1}$	31350	36300	-15.78	-
7	Net income $Rs.ha^{-1}$	58525	40435	-	-
8	B:C ratio	2.87	2.11	-	-

Conclusions

The results from the study showed that the dry direct sowing realized the 17.12% increase in net income due to increased grain yield by 28.37% with reduction of cost of cultivation by 15.78%.

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