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Mechanization: wayouts for minimising drudgery reduction in rice cultivation

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ABSTRACT

On farm experiments on direct seeded rice were conducted in Devakottai, Sakkottai, Thirupathur, Kalayarkoil and Thirupuvanam block of Sivaganga district during *Kharif 2013* and Summer 2014 seasons to enhance productivity and net income of rice farmers and these direct seeded rice (DSR) using seed drill demonstration were compared with traditional practices puddle transplanted rice (PTR), machine transplanted rice (MTR), manual broadcasting followed by tractor harrowing, manual broadcasting followed by country plough harrowing and system of rice intensification (SRI). The results of the experiments revealed that the highest yield of 7.42 kg/ha was recorded under DSR method of crop establishment as compared to conventional (manual broad casting (5.94 kg/ha) and PTR (5.7 kg/ha) and other improved practices like machine transplanted rice (6.4kg/ha) and SRI (7.6 kg/ha). The highest net return of Rs. 77,110/ha and benefit cost ratio of 4.98 were observed under DSR method of crop establishment besides minimizing cost of cultivation (Rs.8200/ha, labour saving and crop matured 7 days earlier than PTR.

Key words: Direct seeded rice, seed drill, weed, pre monsoon seeding.

Transplanted rice has deleterious effects on the soil environment for the succeeding crops. Direct seeded rice which removes puddling and drudgery of transplanting the young rice seedlings provides an option to resolve the adaphic conflict and enhance the sustainability of rice based cropping system. Puddling requires lots of scarce water at a time when there is little water in the reservoirs, destroys soil structure and adversely affects soil productivity. DSR overcomes the problem of seasonality in labour requirement for rice nursery raising and transplanting operation. Therefore, change in the method of crop establishment from traditional manual transplanting of seedlings in to direct seeding is inevitable and considered as resource saving, potential alternate technology for attaining higher productivity with reduced cost of production.

Paucity of labour during peak period of cultivation, unavailability of skilled labour, steep increase in wages and looming water scarcity during drought in transplanting rice system, farmers search for alternate establishment method for drudgery reduction and enhancing water productivity. Consequently, direct sown dry seeded rice is gaining momentum in Tamil Nadu and therefore, it is imperative to study the efficient and inexpensive techniques for sowing, weeding and nutrient management to enhance the productivity and improve the livelihoods of rice farmers (Kathirvelan *et al*., 2014). With rice farming activities picking up in Southern part of Tamil Nadu, rice farmers have been struggling to get farm workers for labour intensive activities such as transplantation, weeding and other inter cultural operations owing to migration of agricultural labourers to other sources of livelihood activities. Paucity of agricultural labourers particularly during peak period of cultivation leads to delayed sowing/transplanting and weeding which results in poor yield (Kathirvelan *et al*, 2012). Consequently, mechanization in rice cultivation is gaining momentum, due to acute labour shortage, unavailability of skilled labour, steep increase in wages and other expenses (Gangwar *et al*., 2008). Looming water crisis, water-intensive nature of rice cultivation and escalating labour costs drive the search for alternative crop establishment methods to increase water productivity in rice cultivation, Direct seeded rice (DSR) has received much attention

because of its low-input demand. It involves sowing pre-germinated seed into a puddled soil surface (wet seeding), standing water (water seeding) or dry seeding into a prepared seedbed (dry seeding). Considering this, Directorate of Crop Management, Tamil Nadu Agricultural University in collaboration with Dryland Agricultural Research Station, Chettinad has implemented on farm research demonstration on direct seeded rice under NADP (RKVY) scheme, to enhance productivity and net income of rice farmers.

MATERIALS AND METHODS

Operational Area: In order to popularize mechanization in direct sown rice cultivation and to enhance productivity and net income of rice farmers, a series of on-farm research experiments on Direct Seeded Rice (SR) were implemented in Devakottai, Sakkottai, Thirupathur, Kalayarkoil and Thirupuvanam block of Sivaganga district during *Kharif 2013* and Summer 2014 season by Dryland Agricultural Research Station, Chettinad. The size of the demonstrated plots varied from 0.5 acre to 1.0 acre and totally 51 demonstrations were conducted in the farmers' holdings. Open well is the major source of irrigation for this village. However, tanks and borewells are also the major sources of irrigation. The average annual rainfall of the region is 940 mm with maximum area under rice–rice cropping system and there is no dearth of resources and is bestowed with all natural resources. On farm demonstration on irect seeded rice (DSR) using seed drill were compared with traditional practices puddle transplanted rice (PTR), machine transplanted rice (MTR), manual broadcasting followed by tractor harrowing, manual broadcasting followed by country plough harrowing and system of rice intensification (SRI).

Constraints: Traditionally, farmers of this region used to grow rice through manual puddle transplanting (PTR) and they were looking for an alternative crop establishment method to PTR because of its higher labour, energy and water use. For transplanting operation alone, they used to hire 15 mandays to cover an acre of land and the approximate cost towards the transplanting costs was around Rs.3000 per acre on contract basis. Consequently, mechanization in rice cultivation is gaining momentum among the farming communities across the state, due to acute labour shortage, unavailability of skilled labour, steep increase in wages and other expenses.

RESULTS AND DISCUSSION

Time of pre monsoon sowing: Pre monsoon sowing time is an important factor that determines the productivity of direct sown rice particularly under dry seeded situation. Therefore, sowing time and length of growing period needs to be standardized for each agro ecological zone for successful DSR. As for as Sivaganga district is concerned, 3rd to 4th week of September is ideal time for pre monsoon sowing that enabled the crop to escape from the early and terminal drought besides minimizing the risk of seedling mortality owing to inundating monsoon rains. Accordingly, the on-farm trials were implemented with an area of 25.0 ha utilizing the tractor drawn multi crop happy seed drill at Sakkottai, Thirupathur, Devakottai, Kalayarkoil and Thirupuvanam Block of Sivaganga District during Kharif 2013 and Summer 2014 season.

Seed drill sowing: Sowing was done by utilizing the tractor drawn happy seeder with incline plate metering mechanism which favored the altering of inter and intra row spacing. Consequently, seeds were sown with a spacing of 30 cm apart which facilitated easy operation of power weeder and other inter cultural operations.

Crop establishment: For better germination, establishment of rice seedlings and success of DSR, placement of rice seeds at the optimum depth (2-3 cm for clay loam and 3-4 cm for sandy loam) is pre requisite. The risk of gaps in the intra row and inter row spacing due to machine vibration was very low in this inclined plate type metering system. Therefore, optimum plant population load was maintained in all the on-farm experiments which resulted in higher productivity as compared to Puddle Transplanted Rice (PTR). The advantages of the DSR over the conventional broadcasting (semidry rice) and PTR are furnished in table 1&2.

Weed management: Weed poses a series problem in DSR and an effective weed management is a big challenge for the adoption of DSR by the rice growing farmers. Since, DSR does not required any puddling operation as in the case of PTR where standing water suppress and prevent the germination and growth of many weed species. Whereas, weed flora in the DSR is diverse and consists and the crop weed competition in DSR is higher than the PTR and there is greater risk for crop yield loss due to weed infestation. Non availability of labourers particularly during peak weeding period pose a serious problem to the rice farmers that leads to delayed weeding

operation which resulted in poor crop growth and productivity. Moreover, manual weeding is laborious, time consuming and cumbersome now a days. Hence, effective weed management strategy with new molecules of pre and early post and post emergence herbicide application in integration with agronomic practices viz., power weeding/cono weeding is pivotal for the success of DSR.

Table 1. Comparative performance of DSR Vs Manual Broadcasting.

Establishment Method (in acre)	Manual Broadcasting (Tractor harrowing)	Manual Broadcasting (Country plough harrowing)	Seed Drill Sowing
Time Taken (in hrs)	1	5	45
Seed Rate (Kg)	35	35	15
Labour Requirement	1	2	1
Cost involved for sowing	1000	1200	600
Irrigation intervals	9	9	9

Table 2. Comparative performance of DSR Vs Manual and Machine PTR.

Establishment Method (in acre)	Manual PTR	Machine PTR	SRI
Time Taken (in hrs)	8	2	8
Seed Rate (Kg)	30	15	3
Labour Requirement	15	3	10
Cost involved for sowing	3000	3500	2500
Irrigation intervals	7	7	10

Table 3. Comparative performance of Chemical Weeding Vs Manual Weeding

Weed Management Practices (in acre)	Chemical Weeding	Manual Weeding	Saving
Cost involved (in Rs)	1150	3750	2600
Labour requirement (mandays)	10	25	15

Table 4. Effect of different insitu soil moisture conservation techniques on yield and economics of foxtail millet variety CO 7 under rainfed condition.

Treatment	Grain yield (kg ha^{-1})	Fodder yield (kg ha^{-1})	Cost of Cultivation (Rs ha^{-1})	Gross Income (Rs ha^{-1})	Net Income (Rs ha^{-1})	BCR (Rs ha^{-1})
Broad Bed and Furrow	799	4412	23500	35955	12455	1.5
Compartmental Bunding	1737	5772	22750	78165	55415	3.4
Ridges and Furrows	1746	5982	23000	78570	55570	3.4
Tied Ridges	1877	6654	23500	84465	60965	3.6
Basin Listing	1426	4851	23000	64170	41170	2.8
Vertical Mulching	1447	4912	24500	65115	40615	2.7
Flat Bed	1140	4456	22750	51300	28550	2.3
S.Em±	86.8	200.9	-	-	-	-
CD (P=0.05)	189.2	437.8	-	-	-	-

Table 5. Comparative performance of DSR Vs Manual and Machine PTR

Establishment Method (in ha)	Manual PTR	Machine PTR	SRI
Time Taken (in hrs)	8	5	8
Seed Rate (Kg)	75	37.5	7.5
Labour for planting	50	3	40
Cost involved for planting (Rs)	7500	8750	6000
Irrigation intervals (days)	7	7	10
Yield (kg/ha)	5.7	6.4	7.6
Cost of cultivation (kg/ha)	34750	35250	25900
Gross return (kg/ha)	74100	83200	98800
Net return(kg/ha)	39350	47950	72900

The predominant weed flora observed in the on-farm experimental trials were *Cyperus sp., Echninochloa, Fimbristylis sp., Leptochloa, Sphenochlea sp.,* and *Marshellia sp., Eclipta.* In the on-farm experimental trials, application of pretilachlore @ 0.5 kg a.i./ha at 5 DAS as pre emergence and early post emergence with Azimsulfuron @ 20 kg a.i./ha at 15 DAS had effectively controlled all the types of weed flora including sedges (*Cyperus rotundus*) but it is in effective against the grasses particularly *Fimbristylis sp*. These findings are in accordance with the results of Maity Swapan Kumar and Mukherjee (2011). The cost and time advantages of chemical weed management over manual weeding are given in table 3.

Yield advantages: Based on the results of the on-farm experimental trials conducted in Sivaganga District, revealed that the highest yield of 7.42 kg/ha was recorded under DSR method of crop establishment as compared to conventional (manual broad casting (5.94 kg/ha) and PTR (5.7 kg/ha) and other improved practices like machine transplanted rice (6.4kg/ha) and SRI (7.6 kg/ha). With respect to cost of cultivation, higher values were recorded under machine transplanted rice (Rs.35,250/ha) followed by manual PTR (Rs.34,750/ha) and the least values were noticed with DSR (Rs.19,350/ha) which is followed by SRI (Rs.25,900/ha). Though the highest gross return was recorded under SRI method of rice cultivation (Rs.98,800/ha) which is higher than that of DSR (Rs.96,460/ha), it failed to provide higher net return (Rs.72,900/ha) due to its higher cost of cultivation (RS.25,900/ha) as compared to DSR. The highest net return of Rs. 77,110/ha and benefit cost ratio of 4.98 were observed under DSR method of crop establishment. The details of labour utilization, time taken for sowing, yield an economics are furnished in table 4&5.

DSR could able to produce on par yield and even higher yield than that of traditional PTR besides minimizing cost of cultivation (Rs.8200/ha, labour saving and crop matured 7 days earlier than PTR. Moreover, transplanting shock can be avoided in direct seeded rice than transplanting which results in growth delays and hastens physiological maturity and reduces vulnerability to late-season drought (Tuong *et al*., 2008). DSR have less methane emissions (Wassmann *et al*., 2004) and hence offer an opportunity for farmers to earn from carbon credits than PTR system (Balasubramanian and Hill, 2002). According to the feedback from the local farmers revealed that labour and water savings are the major drivers of DSR adoption in Sivaganga District. After seeing the beneficial effects of DSR method of establishment, many farmers in this region have adopted this DSR technique.

CONCLUSION

From this study, it could be concluded that direct seeding with tractor drawn seed drill performed superior in terms of maintaining optimum population load, productivity and profitability over PTR and SRI besides conserving the resources. Application of pretilachlor @ 0.5 kg a.i./ha at 5 DAS as pre emergence and early post emergence application with Azimsulfuron @ 20 kg a.i./ha at 15 DAS had effectively controlled all the types of weed flora which resulted in higher weed control efficiency over conventional practices.

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