The Pharma Innovation Journal 2022; 11(3): 2199-2202

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(3): 2199-2202

www.thepharmajournal.com
Received: 15-01-2022
Accepted: 26-02-2022

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Direct seeding: An alternative climate resilient smart profitable practice to traditional transplanting practice

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Abstract
Field demonstrations were conducted on direct seeding through dry converted wet method of cultivation in rice by use of seed drill in Nacharam village of Khammam district, under National Initiative on Climate Resilient Agriculture project (NICRA). There was considerable reduction in cost of cultivation in dry converted wet rice method (Rs. 21,612.5 ha^{-1}) as compared to transplanting method. In dry converted wet method of cultivation there was saving in cost towards land preparation **(**Rs.3,750 ha^{-1}), seed+ seed treatment (Rs.1,625 ha^{-1}), sowing (Rs.2,500 ha^{-1}) and also saving in time, cost towards nursery and transplanting as compared to transplanting method. Maximum net returns obtained in dry converted wet rice method (Rs. 82080 ha^{-1}) as compared to transplanting method (Rs.56,237.5 ha^{-1}). Thus there is an additional income of Rs.25,842 ha^{-1} in dry converted wet rice method. The cost: benefit ratio was also higher in dry converted wet rice method (2.95) as compared to transplanting method (1.88). The dry converted wet rice technology serves as a climate resilient practice and a boon for the rice farmers in saving natural resources like water, overcome labour shortage, saving in time and reduction in the cost of cultivation towards land preparation, nursery and transplanting and stands as an alternative to traditional transplanting method.

Keywords: Direct seeding rice, dry converted wet, transplanting, climate resilient, NICRA and rice

Introduction
Rice (*Oryza sativa* L.) is one of the most important food crops in the world, and staple food for more than 50% of the global population. Being the major source of food after wheat, it meets 43% of calorie requirement of more than two third of the Indian population (Kaur & Singh, 2017). In Telangana, rice is cultivated in an area of 16.31 lakh ha with a production of 59 lakh tonnes and productivity of 3.67 tonnes ha^{-1} during the year 2019-20 (Directorate of Economics and Statistics, 2022) [4]. Rice growers are increasingly facing water crisis for traditional rice cultivation and increasing labour cost challenges. Transplanting of rice entails adequate land preparation both for nursery and main field, consumes 20% of the total water requirement ha^{-1} (1240 mm) and requires 25 to 30 man days for its establishment manually depending on soil type. Rice is a major freshwater user and consumes about 50% of total irrigation water used in Asia (Barker *et al*., 2020) [15] and accounts for about 24-30% of the withdrawal of world total freshwater and 34-43% of the world's irrigation water (Bouman *et al.*, 2007) [2]. Increasing water scarcity, water loving nature of rice cultivation and increasing labour wages triggers the search for such alternative crop establishment methods which can increase water productivity. In Khammam district, under conditions of late onset of monsoon and insufficient water in barrages, water may become erratic and untimely leading to delayed transplanting. Due to deficit monsoon, delayed and limited release of water from reservoirs farmers do not get sufficient water at right time and they have to complete transplanting within a short time of water availability. Direct seeded rice (DSR) is the only viable option to reduce the unproductive water flows. Direct seeded rice refers to the process of establishing a rice crop from seeds sown in the field rather than by transplanting seedlings from the nursery. It has been recognized as the principal method of rice establishment since 1950's in developing countries (Pandey and Velasco, 2005) [14]. With direct seeding, rice seed is sown and sprouted directly into the field, eliminating the laborious process of planting seedlings by hand and greatly reducing the crop's water requirements (Lakis Polycarpou, 2010) [11]. Since the water resources (both surface and underground) are shrinking day by day (Farooq *et al*. (2009) [5] and the profit margins are decreasing in puddle transplanting rice mainly because of high labour

cost and water requirement (Chan *et al*. 1993) [3] so, switching over from puddle transplanting rice to direct seeding rice cultivation took place (Pandey and Velasco, 1999) [13].

Nacharam one of the NICRA (National Innovations in Climate Resilient Agriculture) village belonging to Khammam (D), Telangana state has a population of 3246 individuals with 749 number of households. Farmers mainly grow the crops like Paddy, Cotton, Maize, Pulses and Chilli. The village receives an annual rainfall of 1054 mm with uneven distribution. The major soil types are black and red soils. The source of irrigation for cultivating crops is tanks. Farmers are cultivating rice during Kharif season are increasingly facing water shortages due to deficit rainfall, declining ground water table due to insufficient recharge which is a major climatic constraint. Farmers are going for planting the paddy during second fortnight of August only when the water is filled in the tanks because of its non availability and incomplete filling of the water in tanks during the months of June and July. This climatic constraint and situation forcing the farmers to go for late transplanting and reaping lower yields because of the incidence of more pest and diseases in the late planting seedlings and also the season for Rabi crops is getting delayed. Mahajan *et al.,* (2009) [12] reported that delay in transplanting beyond optimum time will cause reduction in rice yield. Sensing the alarming situation of climatic constraint and rainfall vagaries, delayed and limited release of water from tanks; Krishi Vigyan Kendra, Wyra has demonstrated the performance of dry converted wet rice cultivation which is a climate resilient smart profitable practice as an alternative to the conventional method of transplanted rice which could avoid the present day condition to some extent and cultivation of paddy can be carried out at an affordable cost.

Material and Methods

Existing Practice

Most of the Farmers following transplanting method of rice in NICRA village, facing water shortage due to deficit rainfall and late and limited release of irrigation water from canals. Transplanting of rice entails, adequate land preparation both for nursery and main field, the process consuming 20% of the total water requirement/ha (1240 mm). It also requires 25 to 30 man days for manual establishment of the same, depending on soil type.

Resilient technology

Direct seeding through dry converted wet rice method with seed drill in rice is a climate resilient smart profitable technology and serves an alternative to transplanted rice to overcome shortage of irrigation water and labour. Direct seeding through dry converted wet rice gives the farmer feasibility to take up sowing of paddy with a suitable duration variety to fit into the season. Besides the savings in labor and water, economic benefits brought out by direct seeded rice through the integration of an additional crop (crop intensification) are another reason for the rapid adoption of direct seeded rice. Earlier maturity of direct seeded rice as compared to puddle transplanting rice fits this crop well in different cropping systems (Gill and Dhingra, 2002) [8].

Introduction and demonstration of climate resilient technology i.e. direct seeding through dry converted wet rice was done under NICRA project in place of transplanting method to reduce the cost of cultivation, increase net returns and also to conserve the natural resources. Farmers with the first showers received in the month of first week of June will start preparing the land. At first, land preparation done by ploughing twice with cultivator followed by rotavator to ensure proper land levelling for better water management and sowing. Sowing done in lines through tractor operated seed cum ferti drill which is available in the NICRA custom hiring centre. About 20-30 Kg/ha of the seed is only required for direct sowing as against to the 50-62.5 kg/ha of seed required in case of transplanting method. In general, dry converted wet rice sowings will be done during 2nd fortnight of June to 1st fortnight of July with limited rainfall received during this period. By the month of August, when the water bodies like tanks get filled with water and water is available for paddy cultivation farmers convert it into flooded rice; thus this method has the advantage of saving time (around two months – June and July) without any delay in paddy cultivation. Here, as land is not flooded with water weed menace will be a great issue and application of weedicides at right time will help in keeping the field weed free. Application of Pendimethalin @1.2 lit/acre and Penoxsulam+ Cyahalofop butyl @ 900 ml/acre at 20-25 DAS days after sowing kept the field weed free. Nutrient management for both the direct seeding and conventional transplanting is same except in dry converted wet method, it is advised to apply 25% additional nitrogen than the recommended. Direct seeding through dry converted wet rice is helpful for sowing of crop at right time without waiting for labour and water resources which help in achieving good yields in dry converted wet rice method. Labour shortage at peak agricultural operations and high wages for transplanting can be overcome in case of dry converted wet rice. Due to less labour and time requirement, low cost of cultivation is achieved due to skipping of nursery raising and transplanting. Compared to transplanted method in dry converted wet rice method about 30% of water can be saved and the crop matures 7-10 days earlier. Bhullar *et al*., (2018) [1] reported that direct seeding rice method helps in saving of irrigation water as compared to transplanting method. All the economics from the seed cost, sowing to harvesting was studied in the direct seeding method. Similarly, all the economic parameters i.e., cost of cultivation, gross returns, net returns and cost benefit ratio obtained was carefully studied, calculated and compared in both the systems i.e., direct seeding and transplanting.

Results and Discussion

The results indicated that the total cost of cultivation for dry converted wet rice method was Rs. 42,000 ha^{-1} and for transplanting method it was Rs.63,612.5 ha^{-1}. By comparing both the Dry converted wet Rice Method and Transplanting Method, the major differences in cost of cultivation was achieved because of differences in the costs of operations i.e. land preparation which was Rs.10, 000 ha^{-1} in Dry converted wet rice whereas Rs.13,750 ha^{-1} in transplanting method due to absence of puddling operation in dry converted wet rice and its presence in transplanting method. Thus, the farmers of dry converted wet rice can realize a saving of Rs.3750 ha^{-1} as compared to farmers of Transplanting Method in land preparation. Similarly, there is also differences in costs of seed+ seed treatment which was Rs.1,125 ha^{-1} in Dry converted wet Rice Method and Rs.2,750 ha^{-1} in transplanting method due to the difference in the amount of requirement of seed which was 20-30 Kg/ha in Dry converted wet rice as

against to the 50-62.5 kg/ha in transplanting method. Here also, the farmers of dry converted wet rice can realize a saving of Rs.1,625 ha^{-1} as compared to farmers of Transplanting Method in seed+ seed treatment practice.

Further, since dry converted wet rice method doesn't require the maintenance of nursery, the differences in cost of cultivation arised in both the methods which was Rs.0.0 (absence of nursery) in Dry converted wet rice and Rs.2,500 ha^{-1} in Transplanting Method which requires nursery. The major difference and also a major advantage in dry converted wet rice method is non-requirement of transplanting operation which created a great differences in cost of cultivation i.e. Rs 10,000 ha^{-1} in Dry converted wet rice and Rs.12,500 ha^{-1} in Transplanting Method. Thus, the farmers of dry converted wet rice can realize a saving of Rs.2,500 ha^{-1} as compared to farmers of Transplanting Method. It was also observed that, since weed menace and fertilizers requirement (in dry converted wet method, it is advised to apply 25% additional nitrogen than the recommended) is more in dry converted wet rice method as compared to transplanting method there were few differences observed in cost of cultivation i.e. weed management (Rs.7,500 ha^{-1} in dry converted wet rice and Rs.7,250 ha^{-1} in transplanting method) and Fertilizers (Rs.9,187.5 ha^{-1} in dry converted wet rice and Rs.8,437.5 ha^{-1} in transplanting method) where the cost incurred in dry converted wet rice is slightly more than transplanting method.

All the plant protection measures were taken at appropriate time during the crop period to reduce the pest incidence and to obtain good yield. Unlike in the transplanting method, where there is continuous flooding of water presence which resulted in buildup of more pests and diseases and more number of times of application of plant protection chemicals was comparatively less in dry converted wet rice method. In dry converted wet rice method, where the farmers keep the field dry at initial conditions and convert into wet in the later conditions, following alternate wetting and drying approach at 15-20 days based on the moisture conditions help in less build of pests and diseases and less number of times of application of plant protection chemicals. This situation, resulted in the differences in cost of cultivation in the operation of plant protection in both the methods i.e. Rs.5,687.5 ha^{-1} in dry converted wet rice and Rs.8,925 ha^{-1} in transplanting method. Thus the farmers of dry converted wet rice can realize a saving of money as compared to farmers of Transplanting Method by following proper good practices and plant protection measures at appropriate time during the crop period. The yield levels achieved in both the methods are very near and observed less differences in the yield obtained. Gangwar *et al*., (2008) [6] also reported similar results that there was no significant difference in the yields of direct seeding and transplanting methods of rice cultivation. Similar results were obtained by Kumar and Ladha (2011) [10], Gill *et al.*, (2006) [7] and Joshi *et al*., (2013) [9] that there were no differences for grain yield in direct seeded rice and conventional transplanting methods of rice cultivation.

Table 1: Comparison of cost of cultivation between Dry converted wet Rice Method and Transplanting Method

S. No	Name of the practice	Transplanting (Rs/ha)	Dry converted wet rice (Rs/ha)
1	Land Preparation	13,750.0	10,000.0
2	Seed+ Seed treatment	2750.0	1125.0
3	Nursery	2500.0	0
4	Sowing / transplantation	12500.0	1000.0
5	Weed management	7250.0	7500.0
6	Fertilizer	8437.5	9187.5
7	Plant protection	8925.0	5687.5
8	Harvesting	7500.0	7500.0
9	Total cost of cultivation	63612.5	42000.0
10	Grain yield (Kg/ha)	6375.0	6600.0
11	Gross income	119850.0	124080.0
12	Net income	56237.5	82080.0
13	C:B ratio	1.88	2.95

Maximum net returns obtained in dry converted wet rice method (Rs. 82080 ha^{-1}) as compared to transplanting method (Rs.56237.5 ha^{-1}). Thus there is an additional income of Rs.25,842 ha^{-1} in dry converted wet rice method. The cost: benefit ratio was also higher in dry converted wet rice method (2.95) as compared to transplanting method (1.88).

Benefits through dry converted wet rice as compared to traditional transplanting

- In direct seeding method the cost of cultivation is reduced by Rs. 21,612.5 ha^{-1} as compared to conventional transplanting method and thus an additional income from Dry Converted Wet Rice was Rs.25,842 ha^{-1} which is a big saving to the rice cultivation farmers.
- Benefit: cost ratio was higher in the dry converted wet rice method 2.95 compared to 1.88 in transplanted rice.
- By the start of monsoons during June, most of the farmers could not able to prepare the land and start transplanting, where most of the rainfall water goes as a waste without utilization can be avoided in case of dry converted wet rice.
- Farmers opted for dry converted wet rice system by sowing the paddy crop during 2nd fortnight of June will help to sow *rabi* crops at right period.
- Further, sowing of crop at right time without waiting for labour, water resources will help in achieving good yields in dry converted wet rice method.
- Sowing can be done in stipulated time frame because of easier and faster planting.
- Labour shortage at peak agricultural operations and high wages for transplanting can be overcome in case of dry converted wet rice.
- Late receipt of water into local tanks is only after 2nd fortnight of August, due to this farmers loose two month crop period (June & July) leading to delayed plantings was absent in dry converted wet rice method.
- There is no puddling operation in dry converted wet rice and thus help in conservation of organic matter in the

soil.
- Compared to transplanted method in dry converted wet rice method about 30% of water can be saved and the crop matures in 7-10 days earlier.

Farmers in NICRA village are very happy and satisfied with the demonstration of dry converted wet rice technology and now being followed by more than 60% of farmers in the village with successful income generation. With consistent support and cooperation of Department of Agriculture, ATMA and other allied departments, farmers were given awareness and motivated through various extension activities like demonstrations, trainings, farmer-scientist interaction meetings, print & electronic media resulted in more adoption of technology in the village and nearby villages.

Conclusion

In the changing climate scenario and prevailing climatic constraints, Dry converted wet rice is an alternative technology to transplanted rice to overcome shortage of irrigation water caused due to monsoon vagaries like late onset of monsoon and insufficient water in tanks and also labour scarcity. Dry converted wet rice gives the farmer feasibility to take up rice cultivation with a suitable duration variety to fit into the season. The technique fits into the season as it provides flexibility in growing the crop without waiting for the filling of all water resources and helps in timely sowing. Thus dry converted wet rice technology serves as a climate resilient practice and a boon for the rice farmers in saving natural resources like water, overcome labour shortage, saving in time and reduction in the cost of cultivation towards land preparation, nursery and transplanting and stands as an alternative to traditional transplanting method.

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