Int.J.Curr.Microbiol.App.Sci (2023) *12*(03): 52-59

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 12 Number 3 (2023)**
Journal homepage: http://www.ijcmas.com

Review Article https://doi.org/10.20546/ijcmas.2023.1203.007

Capacity Building of Farmers for Successful Adoption of Direct Seeded Rice-A Case Study of Natural Resource Management

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Keywords

Oryza sativa L, wheat, food crops, global population, paddy

Article Info

Received:
05 February 2023
Accepted:
27 February 2023
Available Online:
10 March 2023

A B S T R A C T

Transplanting the paddy nursery in the rice field prepared after repeated puddling; is the conventional method of rice (*Oryza sativa*) cultivation in India which is not only intensive water user and nutrients uptake but awkward and laborious also. Some of the problems like lowering water table, scarcity of labour during peak periods, deteriorating soil health demands are arises to sustain productivity of rice as well as natural resources. There are some problems/constraints associated with adoption of DSR which can be solved by capacity building of farmers through conducting *demonstrations, kisan goshthies, kisan melas exposure visits and farmers-scientists interaction* for promotion of DSR for its successful adoption as well as extension personnel working in the extension system for transfer of technology. Keeping the above facts in consideration, a case study was conducted in the adopted nine districts of Haryana State. The district level training-cum workshop was organized (one in each district). The data revealed that a total of 2911 farmers/farmwomen (2268 male & 843 female) were participated which were also aware about DSR production technology and its importance in reduction of water use, diesel consumption and labour requirement in paddy cultivation. The village level awareness programmes on DSR were organized in the adopted villages by the KVKs and reported that a total of 3981 farmers/farmwomen (3705 male and 276 female) were participated in village level awareness programmes. The data also showed that a total of 443 demonstrations (one acre each) were conducted during *kharif*, 2022 (May, 2022 onwards for which the inputs like seeds and some critical inputs were provided to the farmers for successful adoption of DSR. The results so obtained revealed that there is significant increase of yield of paddy varies from 3.7 to 8.8 percent in yield under DSR over PTR at farmers' field with benefit cost ratio 3.68 and 3.32, respectively. Nine paddy field days on DSR were organized by KVKs and a total of 321 farmer/farmwomen were participated. Thus, capacity building of farming community for successful adoption of DSR technology is must for its successful adoption, resource conservation technologies and resource use efficiency (land, water and nutrients) in paddy growing districts in the state.

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. In South Asia, rice was cultivated on 60 million hectares (m ha), and production was slightly above 225 million hectares (mt) of paddy,

accounting for 37.5 and 32% of global area and production in 2013, respectively. In India, it is grown on an area of about 43.5 mha with a total production of 105.5mt and productivity of 2.4t/ha during 2014-15. In Haryana, it occupied 15.59 lakh hectares in 2019-20 with total production of 3.3 million mt (2009) to 4.82 million mt in 2020 and productivity of 4.4 t/ha during 2019-20. It shows Haryana has more productivity/ha than national level even though state is facing the scarcity of irrigation water and deterioration of soil health (Bhuiyan *et al.*, 1995; Barker *et al*., 2020).

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. Direct seeded rice (DSR) is the only viable option to reduce the unproductive water flows. DSR 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.

Direct seeding is can be done by sowing of pre-germinated seed into a puddled soil (wet seeding) or standing water (water seeding) or prepared seedbed (dry seeding). Improved short duration and high yielding varieties, nutrient and weed management techniques encouraged the farmers to shift from traditional sytem of transplanting to DSR culture. Direct seeding offers certain advantages like saving irrigation water, labour, energy, time, reduces emission of greenhouse-gases, better growth of succeeding crops, etc. (Gopal *et al*., 2010).

In the conventional transplanting system (PTR), large quantity of irrigation water is used for puddling which breaks capillary pores, destroys soil aggregates and results in formation of hard pan, creating problems for the establishment and growth of succeeding crops. Since the water resources (both surface and underground) are shrinking day by day and the profit margins are decreasing in PTR mainly because of high labour cost and water requirement, so, switching over from PTR to DSR cultivation took place (Budharand Tamilselvan, 2002; Gangwar *et al.,* 2005).

PTR has higher labour demand as compared to DSR as labour is required for uprooting seedlings from the nursery, field puddling and transplanting of the seedlings. Moreover, in case of low labour wages along with adequate water availability prefers transplanting, whereas in alternate case of high wages and low water availability prefers DSR (Gill, *et al.,* 2006; Gangwar *et al.*, 2008).

The reasons for adoption of DSR, types of direct seeding, comparison of DSR and PTR, potential benefits, constraints and possible solutions are discussed in this paper.

Why DSR

There are various reasons which may be responsible for the shift from PTR to DSR as follows:

Major reasons

i. water scarcity; ii. water-guzzling puddled transplanted rice and iii. increasing demand and competition of water from non-agricultural sector.

Water-guzzling puddled transplanted rice

Transplanting of Conventional rice establishment system requires substantial amount of water. It has been reported that water up to 5000 litres is used to produce 1 kg of rough rice. Rice is a major freshwater user and consumes about 50% of total irrigation water used in Asia and accounts for about 24-30% of the withdrawal of world total freshwater and 34-43% of the world's irrigation water.

Increasing demand and competition of water from non-agricultural sector

The share of water for agriculture is declining very fast because of the increasing population, lowering of the water table, declining water quality,

inefficient irrigation systems and competition with non-agricultural sectors. At present, irrigated agriculture accounts for 70 and 90% of total freshwater withdrawal. In the major rice-growing Asian countries, per capita water availability reduced by 34-76% between 1950 and 2005, and is likely to decline by 18-88% by 2050. In Asia, the share of water in agriculture declined from 98% in 1900 to 80% in 2000, and is likely to further decline to 72% by 2020.

Ground Water Scenario of Haryana

The State of Haryana has covered a total of 44212 sq.km areas with average rainfall of 615mm having 22 districts with 108 blocks. Based on yield potential characteristics of aquifers, the State can be divided into three zones. The first one comprises of 26,090 sq.km in parts of Sirsa, Hissar, Bhiwani, Mahendergarh and Jind districts, where tubewells can yield 50m^3/hr. The second one falls in parts of Hisar, Kurukshetra, Karnal, Bhiwani and Gurgaon districts, covering an area of 7100 sq.km tubewells in this zone, can yield between 50-150m^3/hr. The third one extends by 9200 sq.km in parts of Ambala, Kuruskshetra, Karnal and Sonipat districts, where the yield varies between 150-200 m^3/hr. An area of 1660 sq.km in parts of Gurgaon, Bhiwani and Mahendergarh districts is underlain by consolidated formations, where the yield prospects of aquifers are limited. During the present scenario of ground water utilization, India is the largest groundwater utilizer (260 km^3/year) in the whole world. According to the Central Ground Water Board and Development of Irrigation, the number of overexploited blocks have increased from 63 in 1992 to 108 in 2010 (**Source:** http://cgwb.gov.in/gw_profiles/st_Haryana.htm).

Water wise-direct seeding practice

The establishment technologies, which inherently require less water, and are more efficient in water use are demanded by the grim water scenario in agriculture together with the highly inefficient traditional transplanting system. DSR being a water wise technology provides the solution. With increasing shortage of water, Dry-DSR with minimum or zero tillage (ZT) further enhances the benefits of this technology by saving labour (Kumar and Ladha, 2011).

The rising cost and scarcity of labour at peak periods

DSR saves labour as it avoids nursery raising, uprooting seedlings, transplanting as well as puddling. Further the demand for labour is spread out over a longer period in DSR as compared to PTR, where more labour is required at the time of transplanting thus resulting in its shortage. Rapid economic growth in Asia has increased the demand for labour in non-agricultural sectors resulting in less labour availability for agriculture. In Asia, labour forces in agriculture are declining at 0.1-0.4%, with an average of 0.2% per year.

Other reasons

Besides discussion as above, there may be some other reasons which advocate direct seeded rice technology as under:

Adverse effects of Puddling

Puddling breaks capillary pores, destroys soil aggregates, and disperses fine clay particles and form a hard pan at shallow depth. It is beneficial for rice as it control weeds, improves availability water and nutrient, facilitates transplanting and results in quick establishment of seedlings. This is especially relevant to the rice-wheat system in which land goes through wetting and drying phenomenon. It, therefore, becomes imperative to identify alternative establishment method to puddling especially, in those regions where water is becoming scarce.

Rising interest in conservation agriculture

Conservation agriculture (CA) involves zero tillage (ZT) or reduced tillage (RT) followed by row seeding using a drill. Conservation tillage, when utilizes crop residue as mulch with improved crop and resource management methods, is termed conservation agriculture or integrated crop and

resource management (ICRM). Declining/stagnating crop and factor productivity and a deteriorating resource base in cereal systems like rice-wheat have led to the promotion of conservation tillage-based agriculture.

Best fit in cropping system

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 power transplanted rice fits this crop well in different cropping systems. Although, direct seeding is itself resource conservation technology (RCT) and its effects can be further enhanced by adopting laser levelling. Laser levelling is a pre-requisite in the improvement of water use and crop management.

Economics

A major reason for farmers' interest in direct seeded rice is the rising cost of cultivation and decreasing profits with conventional practice. Growers likely prefer a technology that gives higher profit despite similar or slightly lower yield. The cost reductions were largely due to either reduced labor cost or tillage cost or both under DSR systems.

Awareness about DSR technology through Capacity Building of Farmers by conducting various Extension activities at different Krishi Vigyan Kendras in the State. Some of the extension programmes which were planned for promotion of DSR through various KVKs in different paddy growing districts of Haryana state such as (i) District level training-cum-workshop on direct seeded rice (ii) village level awareness programme on direct

Actual advantages from direct seeded rice

Direct-seeding of rice has the potential to provide several benefits to farmers and the environment over conventional practices of puddling and transplanting. The various benefits are as below:

Saves labour.

Sowing can be done in stipulated time frame because of easier and faster planting.

Early crop maturity by 7-10 days which allows timely planting of subsequent crops.

More efficient water use and higher water stress tolerance.

More profitability especially under assured irrigation facilities.

Better soil physical conditions.

Table.1 Capacity building of farmers during District Level Training–cum Workshop on DSR

Sr. No.	District/KVK	Date	Venue	Number of participants		
				Male	Female	Total
1.	Karnal	07.10.2022	Ghraunda	270	30	300
2.	Kaithal	04.08.2022	Lamba Kheri	295	5	300
3.	Yamunanagar	05.07.2022	Bakana	221	104	325
4.	Fatehabad	07.09.2022	KVK Premises	208	108	316
5.	Kurukshetra	10.06.2022	Panchyat Bhawan, Kurukshetra	190	120	310
6.	Panipat	07.10.2022	KVK Premises	350	75	425
7.	Sirsa	06.10.2022	KVK Premises	274	81	355
8.	Sonipat	11.10.2022	Halalpur	220	60	280
9.	Jind	21.10.2022	Jamni	240	260	300
Total				**2268**	**843**	**2911**

Table.2 Farmers' participation during Village Level Awareness programme on DSR

Sr. No.	District/KVK	Number of participants		
		Male	Female	Total
1.	Karnal	370	130	500
2.	Kaithal	450	50	500
3.	Yamunanagar	466	25	491
4.	Fatehabad	533	0	533
5.	Kurukshetra	222	65	287
6.	Panipat	598	0	598
7.	Sirsa	520	0	520
8.	Sonipat	504	0	504
9.	Jind	42	06	48
Total		**3705**	**276**	**3981**

Table.3 Demonstrations conducted on Direct Seeded Rice at farmers' field

Sr. No.	District/KVK	Venue (Farmers' field of different villages)	No. of demonstrations (one acre each)
1.	Karnal	Phurlak, Gudha, Mehmadpur, Naseerpur, Araipura, Akbarpur, Bastara, Nali Khurd, Malikpura, Kairwali, Khirajpur, Kalram, Panori, Sanghohi, Jamalpur, Dingar Majra, Jarauli , Sirsi and Nalwipar	50
2.	Kaithal	Lambakheri, Guhna, Simbalwali Kheri, Dillowali and Dubbal	50
3.	Yamunanagar	Jamaalpur, Allahar, Khedapur, Uncha Chandna, Koolpur, Saran, Thana Chappar, Khajuri, Kalesra and Nagla Jagir	43
4.	Fatehabad	Bharpur, Rattakhera, Nimri, Haroli, Dholu, and Nadhori	50
5.	Kurukshetra	Amin, Bibipur Kalan, Dhanura Jatan, Bodhi, and Morthali	50
6.	Panipat	Jalalpur, Naultha, Kard, Paldi, and Budshyam	50
7.	Sirsa	Bajekan, Kharekan, Ramnagria, Ding, Farwai, and Jhorarnali	50
8.	Sonipat	Halalpur-Nahri, Majra, Ramnagar, Moi, Malha Majra, and Shahpur Taga	50
9	Jind	Khunga kothi, Dathrath	50
Total			**443**

Table.4 Front Line Demonstration on Direct Seeded Rice (Var. PB 1509 during *Kharif*, 2022)

Treatment	Yield (Kg/ha)	% increase	Cost (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C
PTR	42.8 (38.3-48.5)	--	43410	140384	96974	3.23
DSR	44.4 (37.4-50.2)	**3.7**	39545	145632	106087	**3.68**

No. of Demonstrations- 50 (0.4ha/demo) Area: 20.0 ha. DOS: 28.05.2022 to 11.06.2022
Market price: ₹. 3280/q. (Combine harvested)

Table.5 Front Line Demonstration on Direct Seeded Rice (Var. PB 1718) *Kharif*, 2022

Treatment	Yield (Kg/ha)	% increase	Cost (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B: C
PTR	35.2 (31.2-40.8)	--	56220	161080	104860	2.87
DSR	38.3 (31.4-43.4)	**8.8**	52350	173945	121595	**3.32**

No. of Demonstrations: 25 Area: 10 ha. DOS: 23.05.2022 to 03.06.2022
Market price: PB 1718- ₹. 4150/q Straw: ₹.15000/ha.

Table.6 Participation of farmers in Paddy Field Day on DSR (one field day per district)

Sr. No.	District/KVK	Venue (Farmer's field/KVK)	Number of participants
1.	Karnal	Jamalpur	30
2.	Kaithal	Peoda	40
3.	Yamunanagar	Kalesra & Uncha Chandna	60
4.	Fatehabad	Bharpur	33
5.	Kurukshetra	Daurala	30
6.	Panipat	KVK Farm, Panipat	40
7.	Sirsa	Handikhera	28
8.	Sonipat	Moi	30
9	Jind	KVK Campus	30
Total			**321**

Seeded rice (iii) demonstrations on direct seeded rice technology at farmers' field and at KVK farms as a model spot for exposure visits of farmers. (iv) paddy field days (v) providing literature to farmers about direct seeded rice during extension programmes and (vi) subsequent issues were discussed during farmers-scientist interaction during the extension programmes for promotion of direct seeded rice in the state.

The detailed information of the extension activities are discussed as under:

One district level training-cum workshop on direct seeded rice was organized per district at concerned KVK farm/district head quarter of the respective KVK. The data presented in table 1 revealed that in the entire nine district a total of 2911 farmers/farmwomen (2268 male & 843 female) were participated which were aware about production technology direct seeded rice and its importance in reduction of water use, diesel consumption and labour requirement in paddy cultivation. The farmers were seen keen interest in adoption of DSR in each district.

Various village level awareness programme on direct seeded rice were organized in all the district at different adopted villages by the Krishi Vigyan Kendras viz., Karnal, Kaithal, Yamunanagar, Fatehabad, Kurukshetra, Panipat and Jind in the state and reported that a total of 3981 farmers/farmwomen (3705 male and 276 female) were participated in awareness programme at village level. The data from table 3 showed that a total of 443 demonstrations (one acre each) were conducted during *kharif*, 2022 from the month of May, 2022 onwards in different adopted villages of nine districts through Krishi Vigyan Kendras for which the inputs like seeds of paddy and some critical inputs were provided to the farmers for successful adoption of DSR on a large scale and created awareness in the demonstrated villages.

On the basis of demonstrated conducted and results so obtained it was revealed that there is significant increase of yield of paddy varies from 3.7 to 8.8 percent in yield under DSR over PTR at farmers' field (table 4 & 5) with benefit cost ratio of 3.68 and 3.32, respectively.

The data presented in table 6 revealed that a total of 321 farmer/farmwomen were participated in paddy fiend days on DSR conducted in different adopted villages by KVKs in which the results of DSR technology were shown to the farmers for its successful adoption on large scale.

DSR sowing is more cost effective technology as compared to transplanting.

Water productivity is high in DSR and exceeds corresponding values in transplanting by >25%.

Labour saving in DSR ranges from 13-37%.
Comparative yields of DSR can be obtained by adopting proper management practices.

DSR is technically and economically feasible, eco-friendly alternative to conventional puddled transplanted rice.

Future Outlook

Awareness amongst farmers regarding new rice varieties for direct seeding along with proper management practices can help in successful adoption of DSR. The change in the weed flora associated with switching over from PTR to DSR can be tackled by systematic weed monitoring programme in association with integrated weed management strategies on sustainable basis.

Proper management of micro elements is also desirable since availability of micro elements is reduced by direct seeding of rice.
Selection of proper soil type along with precise leveling can help to enhance water use efficiency and productivity. Further, the selection of crop varieties with characters like early crop vigour and short statured cultivars with short duration can further increase water use efficiency.

Seed priming technology can help to get rid of the problem of poor establishment of crop and can be further improved.

Despite of the numerous controversies, comparable grain yields may be obtained from DSR if properly managed as compared to PTR. Thus, in the present scenario of global scarcity of water and increasing labour wages, when the future of rice production is at stake, DSR is the most viable option for getting sustainable yields without any over exploitation of the available natural resources.

Acknowledgement

We must render our sense of gratitude to Prof. B. R. Kamboj, worthy Vice-Chancellor, CCSHAU, Hisar for approval of the budgets for conducting awareness campaigns for promotion of DSR in the rice growing districts of the state and also sincere gratitude to Director of Extension Education, CCSHAU, Hisar for providing constant supervision and monitoring of extension activities undertaken and for compiling the valuable information in this article.

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How to cite this article:

Sube Singh and Balwan Singh Mandal. 2023. Capacity Building of Farmers for Successful Adoption of Direct Seeded Rice-A Case Study of Natural Resource Management. *Int.J.Curr.Microbiol.App.Sci.* 12(03): 52-59. **doi:** https://doi.org/10.20546/ijcmas.2023.1203.007