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Direct Seeded Rice as Resource Efficient Technology

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

In Asia, seedlings are typically transplanted into puddled soil to cultivate rice (*Oryza sativa* L.). Due of the manpower, water, and energy requirements of this manufacturing system, it is becoming less lucrative as these resources become more scarce. Additionally, it impairs the soil's physical qualities, negatively impacts the performance of succeeding upland crops, and increases methane emissions. Different issues, such as a declining water table, a manpower shortage during peak seasons, and worsening soil quality, need the use of alternate establishment techniques to maintain both natural resource and rice yield. Due to its low input requirement, ability to reduce greenhouse gas emissions, and ability to adjust to climatic hazards, the direct seeded rice (DSR) technique has gained a lot of attention and popularity in recent years. Dry seed must be sown into a ready seedbed, while pre-germinated seed must be sown into standing water and puddles of soil. Many farmers have switched from transplanted to DSR culture as a result of the introduction of early maturing cultivars, the application of effective fertiliser management techniques, and increased adoption of integrated weed management strategies. In certain industrialised nations, such the USA, Australia, Japan, China, and Korea, DSR technology is heavily mechanised. By switching from conventional rice to DSR, crop water requirements, soil organic matter turnover, improved nutrient management, carbon sequestration, weed management, greenhouse gas emissions, and crop intensification will all be significantly reduced. The transition from PTR to DSR is hampered by

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a number of factors, including a high weed infestation, the development of weedy rice, an increase in soil-borne diseases (nematodes), nutritional disorders, poor crop establishment, lodging, the prevalence of blast, brown leaf spot, etc. By addressing these limitations, DSR may show to be a very viable, economically and technically viable substitute for PTR.

Keywords: Water saving; weeds; green-house gases emission; direct seeded rice; labour intensive.

1. INTRODUCTION

The most significant cereal crop in the world, rice is a primary staple meal for more than half (>3.5 billion) of the global population [1] and accounts for 11% of all arable land [2]. In south Asia, it is widely cultivated and consumed. After China, India is the second-largest producer. It is grown in West Bengal, the northwest of India, Andhra Pradesh, Tamil Nadu, and other regions. Rice seedlings are typically raised in nurseries before being put in the main field. For its transplantation, puddled soil must be continuously flooded. However, muddying up the soil causes it to become hard and requires a lot of water. It also affects the structure of the soil. Rice consumes about half of total irrigation water used in Asia [3].

It was vital to find an alternate rice-growing technique that was more cost-effective, required less manpower, and used less irrigation water. Direct seed rice (DSR) is used to cultivate rice in places with sparse irrigation infrastructure. In poor nations, it has been a fundamental tenet of crop establishment since the 1950s. In comparison to the puddle transplanting approach, the DSR method conserved 14 person-days/ha and 18–20% irrigation water, according to Bhullar et al. [4]. Due to its minimal input and high yield, reduced labour costs, lack of drudgery, early crop maturation, low methane emission, and assistance in enhancing soil health, DSR is becoming more and more popular among poor farmers who have limited land. As observed by Kumar and Ladha [5], it also helps reduce production risks in potential drought scenarios and when rainfall at planting time is variable high. The majority of the nation has experienced a water crisis in recent years, and people now have trouble even getting enough water to drink. Due to the fact that DSR requires 40–45% less water than traditional puddle transplants and uses minimal inputs, it is becoming more and more popular. In addition, it lessens the global warming-causing gases nitrous oxide and methane emissions. Manish Raj and others [6]. Direct-seeded rice (DSR) presents a very strong potential that can meet the world's demand while lowering labour costs by 60%, using 50% less water, and boosting productivity by 5–10%. It entails scattering pre-germinated seeds into standing water, dry soil surface, and wet soil surface (wet seeding) [7].

1.1 Direct Seeded Rice

The Direct Seeded Rice (DSR) technology can get over the restrictions and limits of conventional production methods since it is resource-efficient. Alternative techniques like DSR that not only lower the cost of production but also ensure its sustainability have become necessary due to various limitations of traditional cultivation technology, including higher water and labour demands, additional costs during nursery raising, uprooting and transplanting, uncertain supply of irrigation water, and increased frequency of drought.

The majority of the rice grown in the North-Western Indo-Gangetic Plains (IGP) is transplanted. In order to generate a dense clay layer in the subsoil and stop seepage losses, transplanting calls for at least 25 ha-cm of water. To achieve yield levels of approximately 6 2 t/ha, the crop needs to receive roughly 10 ha-cm of irrigation, as well as the adoption of a suitable variety and application of the necessary fertiliser dose. Paddy farming in the area typically uses 40% of all irrigation water. An estimated 10% of the world's methane emissions are thought to come from flooded rice fields. Additionally, paddy production, which is a source of nitrous oxide emissions, is frequently characterised by the careless application of nitrogenous fertilisers. Farmers typically start planting coarse rice in Punjab. The quality of natural resources, such as land and water, has decreased as a result of the current practise of excessive ground water exploitation.

Alternatives to transplanted paddy that are suitable for direct sowing have been discovered by researchers. It is not necessary to raise nursery plants for transplantation when growing rice transplanting owing to peak demand, can be avoided by farmers. DSR allows the farmer

flexibility to undertake direct paddy sowing with a suitable duration variety to fit into the remaining season in the event of a delayed monsoon or a water scarcity. This enables the succeeding rabi wheat to be sown in due time. Rice that is directly seeded requires less water than rice that has been transplanted and flooded. In comparison to rice that has been transplanted, irrigation water pumping requires less energy, and savings can be significantly larger when there is a lack of rain. In the North-West IGP region, direct sowing can be used to grow both coarse and basmati rice whenever practical.

Due to its ability to conserve expensive and limited resources like labour and water while lowering GHG emissions, direct seeded rice (DSR) has emerged as a productive and financially viable alternative to PTR. Many Asian nations, including Malaysia, Sri Lanka, Vietnam, Thailand, Cambodia, and the Philippines, have recently adopted a widespread DSR practise. South Asia is one of several other nations going through this change from manual transplanting to mechanised DSR. Alternative methods of rice establishing that are labour and water efficient, like DSR, will be the preferred way of rice cultivation in the future as labour and water become more expensive and scarce.

2. METHODOLOGY

2.1 Direct Seeded Rice in Un-Puddled Field

In order to effectively manage the weed problem, direct seeding of drought-tolerant rice varieties in dry soil is carried out in June with pre-emergence herbicide application (pendimethalin 1 kg/ha) under adequate soil moisture conditions, followed by a post-emergence herbicide application (bispyribac sodium 25g/ha) at 25-35 days after sowing or hand weeding at 35-45 days after sowing. Another method tried was direct sowing in a moist field after receiving June rainfall or by using ground water and pre-emergence herbicide. Glyphosate-based weed control techniques combined with zero-till direct rice seeding after one day after herbicide application are also used. In the second week of July in Bihar, direct sowing of medium-duration types (125 days) can be carried out in the midlands, followed by the application of a post-emergence herbicide. With the start of monsoon rains, direct seeding of rice can be done on uplands. A zero-till drill is used for direct rice sowing. Compared to transplanted paddy, which required 60–80 kg/ha of seed, the amount needed is 20–25 kg/ha.

Due to the following benefits, DSR with reduced tillage is an effective resource conservation technique with high potential in the Indo-Gangetic Plains:

- Saving 35 to 40 man days/ha
- Enhanced fertiliser use efficiency due to placing fertiliser in the root zone
- Early maturity of crops by 7-10 days helps in timely sowing of succeeding crops.
- Saving in water up to 25% in DSR
- Saving in energy up to 27% of diesel as pumping energy is saved for field preparation, nursery raising, puddling and reduced frequency of applying irrigation water

Little disruption to soil structure; decreased methane emissions and potential for global warming; and increased system productivity. Technology for conserving resources includes sowing dry direct seeded rice with little disturbance to the soil and covering the soil with crop wastes to increase soil productivity. Since traditional puddled transplanting is labor-intensive and necessitates high ploughing, it forces rice yields to change in favour of resource-conservation technologies. In light of the fact that dry-seeded rice (Dry-DSR) with zero or reduced tillage (ZT-RT) has become a competitive option. The most crucial elements for a dry direct drill-sown rice crop are (a) level land, (b) precise water management, and (c) efficient weed control. Because it (a) promotes uniform germination, (b) promotes good water management, (c) improves the cultivation area, (d) improves input usage efficiency, and (e) boosts crop output, nicely levelled soil is crucial for the success of DSR. To maintain good soil moisture for drilling and good soil-to-seed contact, the soil should be thoroughly ground prior to conventional-tillage dry drill seeding (CT-dry-DSR). With minimal or no tillage in sandy or silt loam, a great seedbed can be created, saving soil and money. It's crucial to use non-selective herbicides to suppress annual and perennial weeds while using dry drill sowing with zero-till. Uncertainty surrounds the question of whether a high seed rate is primarily employed to suppress weeds.

Using a higher seed rate per unit area will result in more panicles and a higher seed rate. All rice varieties require careful seeding, but semi dwarf

plant types require it much more due of their shorter mesocotyl length than standard tall varieties. To achieve good seed stand, rice should only be seeded a maximum of 2.5 cm deep, and it has to have enough moisture for germination. In drill-seeded rice, precise water management is essential, especially during the first 7 to 15 days following sowing. The secret to preventing seed rot is to maintain moisture and avoid saturation levels. Just after sowing in dry soil, light irrigation of crops under water stress conditions is advised.

- The combination of cultural, chemical, mechanical, and biological control of weeds results in effective and efficient weed management. Some research have demonstrated efficient management techniques that can be used to control weeds in Dry-DSR. Understanding the biology and ecology of particular troublesome weeds can also improve IWM by allowing for the efficient identification of weak points in weed life cycles. 1) A cultural approach, which includes cover crop alternatives for weed control, proper crop stand and establishment techniques, cultivar selection, crop rotations, and stale seed bed technique. 2) Mechanical Approaches - should incorporate the following weed control methods Utilising weedeaters, solarizing the soil, mulching, laser land levelling, and 3) Chemical approach - Pre and post emergence herbicidal spray is one of the most efficient methods for weed management. 4) Biological approach - Some bio-herbicides can be used to reduce or control the growth of weed species.
- Except that a slightly greater dose of N (22.5–30 kg ha-1) is advised in DSR, general recommendations for NPK fertilisers are identical to those in puddled transplanted rice.
- The importance of DSR demonstrates that farmers' practises and transplanted rice have lower cultivation costs, larger net returns, and better B/C ratios. According to Gangawar et al. [8], direct seeded rice has a higher benefit to cost ratio than rice that has been transplanted.
- Similar results were seen by Kumar [9], who discovered that the B C ratio was higher in DSR than in manually puddled transplanted rice (1.19–1.27). These findings are consistent with those made by Sidhu et al. in [10].
- For Bed-dry-DSR, a bed-planting machine is used, which after preparing the ground, creates a bed (a raised bed measuring 37 cm broad and furrows measuring 30 cm wide), applies fertiliser, and drills the seed on both sides of the bed all at once. This approach is known as Dry-DSR because the seedbed is dry (unpuddled) and the seed environment is primarily aerobic. This technique has long been used in Asia's rain-fed upland, lowland, and flood-prone regions [11]. But lately, this technique has become more significant in irrigated areas where water is growing limited. In irrigated or advantageous rainfed locations, drill seeding is favoured over broadcast seeding in both developed and developing nations because it allows for line sowing, makes it easier to control weeds between rows and saves time and seeds.
- In recent year most part of country undergoes the water crisis and people face a problem even for drinking purpose. So, DSR gaining more popularity over conventional puddled transplanted due to 40-45% less water requirement and low inputs are used. On parallel to parallel it also reduces the methane emission and nitrous oxide, responsible for global warming [6].

2.2 Direct Seeded Rice in Puddled Field by Drum Seeding

Pre-germinated paddy seeds are directly sown in drums composed of fibre material using the drum seeding technique, which produces lines of seeds 20 cm apart in wet and flat fields. The paddy seed is soaked in water over night and allowed to sprout at a rate of 35 to 40 kg per hectare. It's important to avoid delaying planting since seeds with long shoot growth aren't good candidates for drum seeding. Prior to sowing, the sprouted seed is temporarily air-dried in shade (about 30 minutes) to facilitate dispensing via the drum seeder's holes. The excess water in a soggy field is removed, keeping the soil's top moist. In order to plant seeds equally, drums are loaded with sprouted seeds and dragged across the field at a constant speed. Between 4 and 8 drums may be used, and between 8 and 16 lines may be sowed in one pass. For two to three days following seeding, irrigation water shouldn't be used to allow for roots and soil anchoring. However, the freshly sowed seeds are probably going to be washed away by strong rain just after sowing. The water level in the field can raise as

the seedlings mature for improved weed control. Up until the panicle initiation stage, intermittent irrigation is used. Herbicide is administered as soon as possible after seeding, and if necessary, a second application is made 30-35 days later, in areas with a serious weed issue. With line sowing, a modified conoweeder can be used in the same direction as a drum seeder between the rows. When pregerminated seeds are sown/drilled into puddled soil, the seed environment is mostly anaerobic and this is known as anaerobic Wet-DSR. In both aerobic and anaerobic Wet-DSR, seeds are either broadcast or sown in-line using a drum seeder [12,13] or an anaerobic seeder with a furrow opener and closer [14]. Three people can finish drum seeding a one ha area in 5 to 6 hours as opposed to the 30 to 40 man days needed for a transplanting operation. In addition to increasing output, this method can reduce the need for labour, water, and seed thanks to line sowing (which places 20 cm between rows) and the crop's 7–10 day early maturity [15,16]. Drum seeding lowers farming costs since it eliminates the need for paddy nursery raising and subsequent transplanting. The method is appropriate for contingency planning because it allows for flexibility in sowing dates in fields prepared using irrigation water or right away after receiving monsoon rains with a crop variety of adequate duration to fit into the remaining season [17,18].

3. CONCLUSION

By switching to DSR instead of conventional rice, crop water needs, soil organic matter turnover, improved nutrient management, carbon sequestration, weed management, greenhouse gas emis sions, and crop intensification will all be significantly reduced. The transition from PTR to DSR is hampered by a number of factors, including a high weed infestation, the development of weedy rice, an increase in soil-borne diseases (nematodes), nutritional disorders, poor crop establishment, lodging, the prevalence of blast, brown leaf spot, etc. By addressing these limitations, DSR may show to be a very viable, economically and technically viable substitute for PTR.

CONFERENCE DISCLAIMER

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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