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Direct Seeded Rice - A Sustainable Solution for Rice Production

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Abstract

Puddled transplanted rice (PTR) is the conventional method of Rice (*Oryza sativa*) cultivation with repeated tillage followed by puddling operations which not only uses water intensively but also involve cumbersome and laborious process. Different problems like lowering water table, deteriorating soil health and scarcity of labour during critical periods driving towards an alternative and sustainable rice establishment and production system. Direct seeded rice (DSR) as a crop establishment method, is having all the features that are deficit in PTR. DSR is a technically and economically feasible, environmentally friendly alternative to conventional pumped and transplanted rice. It offers many advantages *viz*., it requires less water, saves labour, less drudgery, low production cost, early crop maturity, better soil physical conditions for following crops and has low greenhouse gas (GHG) potential with less methane emission. DSR provides the better option to be the best fit in different cropping systems across different climatic zones.

Keywords: Direct seeded rice, Labour scarcity, Resource Conservation, Sustainability

Introduction

Demand for rice is on the rise, projections by the International Rice Research Institute (IRRI) suggest that rice production need to increase by 25% over the next 25 years to meet global demand. To meet this challenge in a sustainable way, we need to produce this additional rice more efficiently and with less labor, water, energy and agrochemicals to reduce the environmental footprint of rice production (Kumar and Ladha, 2011). Traditional rice farming methods use 40% of the world's irrigation water for rice production (Singh *et al*., 2011). Increasing water scarcity due to climate change and competition from urbanization make this traditional method of rice production unsustainable in the long term. Combined with other factors such as labor shortages and declining acreage, new ideas and innovations in rice cultivation are need of the hour to meet rising demand and ensure food security (Bhushan *et al*., 2017).

One of the possible solutions to overcome these challenges is direct-seeded rice (DSR). Direct seeding is a cropping system in which rice seeds are sown directly into the field, as opposed to the traditional method of raising seedlings in a nursery and then transplanting them into flooded fields. DSR is considered one of the most efficient, sustainable, and economical rice production systems used today (Sharda *et al*., 2017). Compared to the Puddled Transplanted Rice (PTR) method widely used in Asia, DSR allows fast sowing and early maturity, conserves scarce resources such as water and labor, is more conducive to mechanization, and reduces greenhouse gas emissions that contribute to climate change. Mechanized DSR also creates new employment opportunities through new service opportunities and is less labor intensive and free of drudgery, making it more attractive to young farmers and women. Although DSR is widely used in the United States, South America and many western countries, its use is limited in Asia, where 90% of the

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world's rice is grown and consumed. This underscores the need for an integrated and scientific approach to make no-till rice socioeconomically and environmentally sustainable.

Agronomic Management Practices for DSR

i) Land Preparation

• Summer ploughing in the fields to control emerging weeds.

• Laser levelling the fields will facilitates uniform irrigation, better germination and lowers production cost.

ii) Machinery Requirement

• Minimum-till drill/ Power tiller drill in normal tilled fields.

• Zero-till drill in conservation fields as depicted in Figure 1.

• Bed drilling in case of planting in beds.

Figure 1: Direct seeded rice cultivation

iii) Seed Priming

• This is partial hydration of seed to a point where germination-related metabolic processes begin butradical emergence should not occur.

• Primed seed can be treated with a fungicide (Emisan) or insecticide (Imidacloprid) or biofertilizer (*Azospirillum)* after soaking to control seed-borne diseases/ insects for 15-20 hours that will enhance crop performance.

iv) Seed Depth and Soil Moisture

• Optimum sowing depth of seed: 2-3 cm. The seed should be covered by soil for proper germination and to prevent bird damage.

• In lowlands and finer textured soils, planking may not be followed after seeding.

• Soil moisture content at seeding should be sufficient for proper germination, *i.e.*, at field condition.

• Add surface mulch that helps in retaining soil moisture for longer period and also improves seedling emergence and reduce weed menace.

v) Seed Rate and Cultivars for DSR

• Seed rate @ 20-25 kg ha^{-1}.

• Basmati and Fine grain cultivars require much less seed.

• Early to medium short duration cultivars having early vigour.

• Some tested and suitable cultivars are: Hardinath1, Sabitri, Sonamasuri, Radha11 and Radha4.

vi) Seeding Time

• Sowing of dry seed should be done at the time of monsoon arrival which coincidences with the time of nursery sowing.

• 1^{st} week of June to 3^{rd} week of June is the suitable period.

vii) Weed Management

• Pre-germinated weeds can be suppressed with glyphosate/ gramoxone (at a dosage of 0.5% two days before sowing) or by 1-2 very shallow ploughs (Stale seed bed method).

• 40-50% reduced weed densities are reported by mulching.

• Mechanical weed control can be done using Hand-weeder manually.

• Chemical control includes pre-plant incorporation with glyphosate or paraquat, Preemergence with pendimethalin or pretilachlor/ butachlor and post-emergence with almix or fenoxaprop or byspyribac sodium.

• Integrated approach is the best management approach for DSR with respect to weeds.

viii) Water Management

• From sowing to emergence, the soil should be kept moist but not saturated to avoid rotting of the seed.

• After sowing on dry soil, flush irrigation is required to moisten the soil when rain is not expected, followed by saturation of the field at the three stages.

• 3-4 leaf stage, tillering, panicle initiation/ anthesis, booting and grain filling are crucial stages at which soil should be kept saturated.

• Implementing Alternate wetting and drying (AWD), mulching and micro irrigation systems saves much water without yield penalty.

Advantages of Direct Seeded Rice

• No significant reduction of yield by maintaining optimal conditions.

• Savings on irrigation water by 12-35% by following efficient water management practices.

• Reduces labor and drudgery by eliminating nursery raising and transplanting.

• Reduces cultivation time cost and energy.

• No plant stress from transplanting.

• Faster crop maturity.

• Lower GHG emissions from field.

• Mechanized DSR provides employment opportunities for youth through service provision.

• Increases total income with high returns on rupee and low cost of cultivation.

Major Constraints

• High seed rate.

• Seeds exposed to birds and pests.

• Crop establishment challenge.

• Higher weed Infestation.

• Higher risk of lodging.

Way Forward

Development of new rice varieties specific to direct seeding along with proper management practices can help in adoption of DSR. On the research front, much remains to be done on nutrient dynamics in soils at DSR and research is also needed on soil ecology of rice soils and weed control at DSR. A site-specific package of production technologies for different rice cropping systems needs to be developed in different rice growing areas. DSR is a more cost-effective technology because the benefit-cost (B:C) ratio ranges from 2.29 to 3.12 compared with transplanting (1.93 to 2.66). Water productivity is high in DSR (Sidhu *et al.*, 2019), exceeding the corresponding values of transplanting by > 25%. Varieties capable of synthesizing osmo-proteins and stress proteins could be introduced. Although methane emissions are significantly reduced at DSR, to combat the increase in N_2O emissions, it is necessary to monitor GHG emissions and develop strategies to reduce N losses relative to N_2O emissions under aerobic conditions. Effective strategies to control pest and disease dynamics will help solve the problem of blast and insect infestation (DSR). Optimizing crop residue cover must be done from a system perspective.

Conclusion

DSR cultivation has been proven as the sustainable way of rice production system by many scientists across the globe and it has been practicing in large scale all over the world. DSR with appropriate conservation measures has the potential to produce slightly lower or comparable yields to transplanted rice (2.2-8.7 t ha^{-1}) and appears to be a viable alternative to overcoming the problem of labor and water scarcity. If not managed properly, weeds can cause partial or complete crop failure at DSR. Labour savings at DSR range from 13 to 37%. Seed priming is a promising approach to overcoming poor plant growth. Adoption is the big challenge in DSR and needed to be addressed in quick future. Farmers in India during recent times there was a large-scale adoption of DSR in North western states like Punjab, Haryana and Western Uttar Pradesh during covid period which was purely driven by labour shortage and farmers there realised the benefits of DSR. In the same way realisation and adoption of DSR need to be done in remaining parts of India for which global and national scientists are paving the path. Being a resource rich country, India was not yet in a state of realisation towards sustainability and it should be done at gross root level, *i.e.*, at farmer level to beat the upcoming resource scarcity and taking forward India as the global leader in agricultural production.

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