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Direct Seeded Rice: A Technique for Sustainable Agriculture

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Rice, scientifically known as *Oryza sativa* L., stands as a vital global food crop and serves as the primary dietary staple for over 50% of the world's population. It plays a pivotal role in meeting the calorie needs of more than two-thirds of India's populace, closely following wheat in significance.

Direct seeded rice (DSR) represents an innovative approach to cultivating aerobic rice, aiming to sustain rice productivity while conserving natural resources. Aerobic rice is a promising technology that can significantly reduce water consumption during rice cultivation, ultimately yielding more rice with less water. DSR emerges as a viable solution to minimize wasteful water usage, providing several advantages over the traditional transplanted puddled rice system (TPR).DSR contributes to water conservation by eliminating the need for nursery seedling preparation, puddling, and transplanting. Consequently, it reduces labor demands by approximately 40% and can save up to 60% of water throughout the entire rice cultivation process, from nursery management to field preparation, reducing seepage, percolation, and evaporation losses. This approach offers numerous benefits, including reduced labor, decreased water requirements, reduced physical strain, earlier crop maturation by 7-10 days, lower production costs, precise seed and fertilizer placement, enhanced fertilizer efficiency, improved soil health, and reduced greenhouse gas emissions across various cropping systems. The concept of "aerobic rice" is envisioned as a response to the growing water scarcity challenge, with the mission of achieving higher rice yields using less water. Aerobic rice holds particular promise for regions where water scarcity or high water costs make traditional flooded rice cultivation unsustainable. Additionally, it can thrive in rainfed areas where rainfall may be insufficient for flooded rice but sufficient for upland crops.In light of climate change attributed to global warming and ozone layer depletion, the world is already experiencing its consequences. Traditional lowland rice cultivation contributes significantly to methane emissions, accounting for 48% of total greenhouse gas emissions from agricultural sources. In contrast, aerobic rice emits 80-85% less methane gas, thus contributing to a safer environment. Furthermore, aerobic rice not only conserves water but also reduces labor, nutrient, and input requirements when compared to irrigated transplanted rice.

Wet-DSR-involves the use of pre-germinated seeds (with radicle lengths of 1-3 mm) that are either broadcast or sown in rows on moist or puddled soil. When these pre-germinated seeds are scattered on the surface of puddled soil, they are exposed to aerobic conditions, leading to what is known as "aerobic wet-DSR" (surface seeding). This method can be accomplished using a drum seeder . Conversely, when pre-germinated seeds are carefully inserted into puddled soil, creating anaerobic conditions, it is referred to as "anaerobic wet-DSR" (subsurface seeding). This process involves sowing seeds in rows using an anaerobic seeder equipped with a furrow opener and closer . The adoption of Wet-DSR is primarily driven by the need to address labor shortages and is currently practiced in regions such as Malaysia, Thailand, Vietnam, the Philippines, and Sri Lank.

Dry-DSR-In the case of Dry-DSR, rice seeds are either broadcast or drilled into dry and unpuddled soil. Dry-DSR encompasses several techniques, including: the broadcast of dry seeds on unpuddled soil, following either zero tillage or conventional tillage or the dibbled method, where seeds are sown in well-prepared fields or the drilling of seeds in rows after conventional tillage or reduced tillage or utilizing a power-tiller-operated seeder or the zero tillage approach or finally the use of raised beds for dry-DSR .

In dry-DSR, the seedbed remains dry (un puddled), and the seed environment is predominantly aerobic. This characteristic gives rise to the name "dry-DSR." Dry-DSR is commonly practiced in various Asian regions, including rainfed uplands, lowlands, and flood-prone areas. In spite of this, there is a growing recognition of the utility of this approach in irrigated regions facing increasing water scarcity. In the case of dry-DSR, land preparation is typically carried out before the arrival of the monsoon season, and seeds are sown prior to the wet season to leverage pre-monsoon rainfall for crop establishment and early growth.Both wet-DSR and dry-DSR have demonstrated their potential to reduce water and labor requirements when compared to the conventional method of puddled transplanted rice .

Package and Practices for DSR

Land preparation: The approach to seedbed preparation is contingent on the chosen tillage method, and it differs between conventional and conservation tillage systems. In the case of conventional tillage for Direct Seeded Rice (DSR), the primary objective is to create a finely pulverized seedbed to preserve adequate soil moisture and optimize the contact between soil and seeds. On the other hand, in Zero Tillage (ZT) DSR, the initial step involves eliminating existing weeds through the use of burn-down herbicides like paraquat (0.5 kg/ha) or glyphosate (1.0 kg/ha).

Planting time: Rice cultivation primarily occurs during the monsoon season (*Kharif*), which is characterized by substantial rainfall. To make the most of these monsoon rains, it is advisable to sow Direct Seeded Rice (DSR) approximately 10-15 days before the monsoon onset. The ideal window for seeding rice ranges from June 1 to July 20, with some flexibility up to July 1, it is evident that seeding after the monsoon's onset presents challenges. The heavy rainfall during the monsoon can hinder crop establishment, leading to poor germination and making it difficult for machinery to access fields due to the wet soil conditions.

Selection of cultivar: Cultivars suitable to local environment should be selectedhave potential to yield more such as BPT 5204, Shobhini, A-67, Shabhagidhan , Vandana, Mugad Siri, Mugadsuganda, MGD-101 for Karnataka (zone 8) .

Sowing methods

a)Dry-DSR

1)Broadcasting-For sowing in one hectare of land, it is recommended to evenly distribute 60-80 kg of seeds either manually by hand or by creating furrows. These furrows can be made using a furrower, ensuring a shallow depth. Subsequently, after the seeds have been broadcast, cover them by employing a spike-tooth harrow.

2)Line sowing-which involves sowing or dibbling behind the country plough, is considered a superior method compared to broadcasting. This approach is especially advantageous when utilizing a seed drill, as it helps achieve an ideal plant population, reduces the required seed quantity, and allows for early intercultivation.To get uniform germination, it is advisable to practice pre-monsoon sowing.

3)Drilling-Machines are used to deposit seeds(80−100 kg per ha). into both dry and moist soil, followed by irrigation. To prevent seeds from being planted too deep, it's crucial to maintain a smooth and level seedbed, ensuring a planting depth of no more than 10-15 mm.One advantage of this method is that it allows for the simultaneous application of fertilizers with the seeds.

4)Dibbling-This type of planting is typically employed in areas characterized by mountain slopes or where the use of plowing and harrowing is challenging.To execute this method, a long wooden pole equipped with a metal scoop at the end is utilized to dig holes. These holes are then used for depositing the seeds, followed by covering them with soil.

b)Wet-DSR

1)Broadcasting-The pre-germinated seeds, evenly distribute 80-100 kg per hectare on recently drained, well puddled seedbeds or in areas with shallow standing water.

2)Drum seeding-Drum seeders are employed to achieve rapid and efficient planting..For planting purposes, it is recommended to prepare 80 kg of pre-germinated seeds per hectare.

After sowing: Thinning and gap filling should be carried out between 14 to 21 days following the initial sowing

Seed treatment: For seed treatment, immerse the seeds in a solution of Carbendazim or Tricyclozole at a concentration of 2 grams per liter of water for every kilogram of seeds and Chlorpyriphos 20 EC @ 15-30 ml/kg of seeds for soil borne pest management . Allow the seeds to soak in this solution for a duration of 24 hours. After the 24-hour period, remove the seeds from the fungicide solution, and then let them dry in the shade for 1-2 hours before sowing to ensure their friability.

Fertilizer management: Direct Seeded Rice (DSR) needs additional 12-15 kg of nitrogen (N) compared to the requirements of puddle-transplanted rice.Recommended fertilizer dose for paddy is the ratio 100:50:50 of $N:P_2 O_5:K_2O$ kg/ha. Additionally 25 kg Zinc sulphate / ha might be given.Employ a seed cum fertilizer drill or planters to apply the complete dosage of phosphorus (P), potassium (K), and zinc sulfate (ZnSO4) along with 23 kg of nitrogen (N) per hectare as the basal application during sowing. The remaining nitrogen should be distributed in three equal portions, to be applied at early tillering, active tillering, and panicle initiation stages.Occasionally, iron deficiency may manifest in Direct Seeded Rice (DSR). To address this issue, it can be rectified by administering 2-3 foliar sprays of a 1% solution of FeSO4 at weekly intervals.

Water management: In regions facing water scarcity, Direct Seeded Rice (DSR) presents a significant potential to achieve elevated water productivity. In the context of Dry DSR, it is essential to follow the rice sowing process with a gentle irrigation, ensuring the preservation of adequate soil moisture levels to facilitate proper seed germination.Following crop establishment, it is recommended to irrigate the fields at regular intervals, typically every 5 to 6 days.

Weed management: Weeds pose a significant challenge to the successful cultivation of Direct Seeded Rice (DSR). Effective weed management is a pivotal practice for achieving success in DSR, as even if all other aspects are meticulously managed, failure to control weeds in DSR will inevitably result in a yield reduction. Hence, when farmers effectively manage weeds in the initial stages, they have the potential to achieve yields equal to or even greater than those obtained through traditional rice transplanting methods.In the initial 30 days after sowing in DSR, non-grassy weeds (broad-leaf weeds) tend to dominate over grassy weeds and sedges.

1)Cultural control-includes hand weeding**.**

2)Stale seed bed-The utilization of the stale seed bed technique is a valuable cultural practice applicable prior to planting various crops to diminish the weed seed bank. This method entails leaving the fields undisturbed after pre-sowing irrigation, allowing weeds to germinate, followed by their eradication through cultivation, non-selective herbicide application (e.g., paraquat or glyphosate), or shallow tillage.

3)Chemical method-Efficient weed management in crop fields can be achieved through the application of pendimethalin (Stomp 30%EC) at 300-450 g/acre or oxadiargyl (Top Star 80% WP) at 40 g/acre as pre-emergence herbicides. Subsequently, for effective control, post-emergence herbicides such as bispyribac (Nominee Gold 10%SL) at (10 g/acre), azimsulfuron 50 %WGG at 12.5-15 g/acre, or a combination of bispyribac with azimsulfuronat 10+7 g/acre can be applied at the recommended rates between 1 to 3 weeks after sowing or at 20-30 days after sowing.

Dry-DSR 25 days after sowing

Wet-DSR 25 days after sowing

Conclusion

Direct-seeded rice (DSR) has emerged as a promising alternative to traditional transplanting methods, with a range of benefits that encompass both agronomic and environmental aspects. Through an extensive review of the literature, it is evident that DSR can contribute to increased resource-use efficiency, reduced labor costs, and improved resilience to climate change, among other advantages. However, successful adoption of DSR is contingent upon careful consideration of several factors, such as weed and pest management, suitable rice varieties, and adaptation to local conditions.

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