



Farmer and Eco-friendly Weeds Control by Managing Climatic Factors Ensures DSR Success Story

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Abstract

Water guzzling Puddle transplanted rice cropping system (Puddle-DSR) introduced in NW-India during Green Revolution becomes main cause of depletion of groundwater, degradation of soils- environment and increase the cost of cultivation. Direct Seeded Rice (DSR) water-friendly seeding rice technology has not adopted by the farmers despite Govt. incentives due to menaces of weeds. The modified TAR VATTAR DSR developed by my research team has successfully adopted on over one million ha areas during the years 2020 and 2021 due to its farmers friendly and Eco-friendly weed control by managing the climatic factors and even without application of any post emergence weed killer. In this cropping system, the sowing of seeding recommended on TAR VATTAR fields (good moisture fields) during dry and hot climate of NW-India (20th May to 10th June) in the irrigated zones when avg. temperatures are high and humidity very low (less than 30%) with application of pre-emergence weed killer immediately after the sowing and further delayed first irrigation at 15-25 days which makes DSR crops nearly weed free and need no application of post emergence weed killer. This Eco-friendly cropping system will also make other summer crops soybean, maize, sorghum, pigeon pea etc. to be weed free by managing the climatic factors and without application of post emergence weed killer in NW and Central India.

Keywords: Farmer; Eco-friendly Weeds; Climatic Factors; DSR Success

Introduction

Transplanted RICE CROPPING SYSTEM MAIN CAUSE FOR GROUNDWATER DEPLETION IN NW-INDIA

Prior to the Green Revolution, NW-India did not grow much rice due to its semi-arid to arid climate being close to *The Great Indian Thar Desert* with annual rainfall less than 600 mm only. But rice cultivation grown phenomenally from 0.5 million hectares (ha) in 1966 to more than 5 million ha in 2010 onwards due to the introduction of Green Revolution technology (dwarf high yielding varieties, transplanted rice cropping system (Puddle TPR) supported by higher uses of chemical fertilizers and irrigation) and favorable Govt. policies (Assured procurement at minimum support prices and subsidized energy and chemical fertilizers). Before the Green Revolution, rice like other summer crops was directly seeded and weeding was done manually because its area was small and labor was plentiful.

While the Green Revolution rice technologies has ensured food security of 1.4 billion Indian during last 5 decades and increase the

export particularly Basmati Rice. However, it has also increased the consumption of pesticides, herbicides and groundwater. Nitrates and phosphates from fertilizers have leached in the soils. Earth warming methane emissions have increased due to introduction of anaerobic (submergence) wetland rice farming system or puddle paddy transplantation (TPR). The water guzzling Transplanted Rice farming systems (TPR) has depleted the groundwater to alarming grey zone levels in a major part of NW-India which leads to the prophecy of shifting rice cultivation to Eastern zone-India by the National policy makers without providing a economically-technically viable alternate cropping system to the farmers.

DSR-Direct seeded rice: Water-friendly seeding technology

On the other hand, the farmers in NW-India were cultivating the rice since ages by using rains dependent sustainable aerobic Direct Seeded Rice (DSR) cropping system. The seeds in DSR are directly sown in un-puddle fields without raising seedlings and their transplantation like other summer cereal crop, either through dry or wet

(pre-germinated) seeding which reduced the requirements of water, cost, energy, labor etc. and mitigates the greenhouse gas emissions and provides viable alternative to the water-guzzling transplanted rice. With proper management, yields from Direct Seeded Rice are comparable to transplanted rice.

To help alleviate some of the negative impacts of Transplanted Rice (TPR), the researchers of ICAR and SAU's have developed direct-seeded rice (DSR) technology during 1990-1995 with an emphasis on weed control by using the chemicals. However, their DSR technology causes simultaneous emergence of rice and weeds seedlings which favors high weed infestations in DSR crops due to defective DOS (15 June onwards - coincides with on-set of monsoon rains in India) and defective method of sowing- dry DSR (Sowing on dry bed *fb* immediate irrigation and further frequent irrigation at 3-4 days interval). Despite the government incentive, farmers have been slow to adopt their DSR technology due to excessive use of post-emergence chemicals to control the high weed pressure and many who tried it (during 1995-2012) soon resumed back to transplanted rice (TPR) by giving a serious setback to the water friendly DSR technology.

TAR VATTAR direct seeded rice technology ensures DSR success story in NWPZ-India.

Then my research team at ICAR-Indian Agricultural Research Institute-Karnal during 2014-17 has developed *Improved TAR VATTAR* Direct Seeded Rice technology while working on research project on 'Use of Herbal Hydrogels for water conservation in crops' and further refined it after my retirement as a 'Farmer's Scientist' during 2017-22 to make it nearly weeds free DSR crop by using 'Eco-friendly Weeds Control by Managing the Climatic Factors' and 'Without Using Post Emergence Herbicides' which Ensures its Success Story in NW and Central India. It becomes popular among the farmers who adopted it on about one million ha areas during the years 2020 and 2021 mainly in the states of Punjab-Haryana.

In *Improved TAR VATTAR* DSR technology, we recommended DOS to be advanced to hot and dry season (20th May to 10th June) for the irrigated zones instead of DOS 15th June onwards (hot and humid season) recommended earlier by the ICAR institutes and States Agricultural Universities. In NW- India, the air humidity during 15th May - 10th June is generally very low (less than 30%) with negligible rainy days (Table 1, Figure 2) and these climatic factors are 'Unfavorable to weeds germination and their growth' which makes *Improved TAR VATTAR* DSR crop nearly weeds free even without the application of post emergence herbicides. By considering the

benefits of DSR sowing during hot and dry season for Eco-friendly weeds control, the Govt. of Punjab and Haryana has also approved the revised DOS as 20th May 2022 onwards for DSR cropping system against the 15th June for transplantation of puddle TPR cropping system under The Preservation of Sub Soil Water Act-2009.

In *Improved TAR VATTAR* DSR technology, the *TAR VATTAR* means 'GOOD MOISTURE FIELDS i.e., sowing to be done in good moisture fields prepared after pre sown irrigation by using 20-25 kg seed ha⁻¹ in NW-India and 50-60 kg seed ha⁻¹ in Central India by using seed drill or age-old broadcasting method by maintaining seed depth at only one inch (2-3cm). To conserve the soil moisture, the sowing is generally recommended only for evening hours and application of weed killer Pendimethaline @ 5 liters in 500 liters water ha⁻¹ immediately after the sowing. Further, first irrigation is delayed by 15 to 25 days after the sowing and later irrigation by adopted AWD cycle of 7-10 days on the basis of types of soils and rains pattern which make DSR crops nearly weeds free without the application of post emergence herbicides '(Figure 1). During last 7 years, we observed that 'In *Improved TAR VATTAR* DSR sowing, emerging rice seedlings has not shown any sign of heat stroke and mortality in vast track of NW-India stretching from western dry districts of Ganganagar/Bhiwani to eastern humid districts of Udham Singh Nagar etc. due to hot (40 °C and above) and dry climate(less than 30% air humidity' by proving that 'Rice has strong inbuilt heat tolerance mechanisms during its early growth stages like other summer food grain crop sorghum, maize and pearl millet etc. '(Figure 3). For light soils at the time sowing of *TAR VATTAR* DSR, we recommend the soil application of herbal hydrogel Gum Tragacanth(E-413) @ 15-20 kg ha⁻¹ to maintain the moisture in the soils which is economically available in grocery stores in NW-India @ US\$ 20 ha⁻¹.

The farmers, even those from arid and semi-arid zones of NW-India and Central India have successfully adopted the *TAR VATTAR* DSR technology on large areas due to its Eco & farmers friendly packages of practices and highly reduced water requirement which is similar to other summer food grains and pulses crops. Compared to the high cost of labor and inputs for water guzzling transplanting rice, the improved DSR technology is saving them about 40% in irrigation and costs of cultivation without any yield penalty. Rather it's reported that 'DSR followed by ZT wheat gave higher system yield and gross margin and production cost reduced by US\$ 149 ha⁻¹ in DSR than in PTR-Puddle Transplanted Rice'. With this technology energy and fertilizers consumption reduced and there is also environmental gains as well and groundwater recharge

Month	Avg. Temp. (°C)	Avg. Max. Temp. (°C)	Humidity (%)	Rainy days	Rainfall (mm)
January	11.9	18.8	70	3	40
February	15.0	22.2	62	4	50
March	20.4	28.4	48	4	39
April	26.9	35.6	30	4	25
May	30.7	38.6	30	4	28
June	31.0	37.4	58	8	89
July	28.1	33.1	76	16	195
August	27.1	31.9	81	16	193
September	26.0	31.5	74	8	100
October	23.0	31.0	57	2	14
November	19.8	26.7	56	1	5
December	14.7	21.3	66	1	15

Table 1: NW-India Haryana Weather (ICAR-IARI Karnal).

Source: <https://en.climate-data.org/asia/india/haryana/karnal-53348/>.

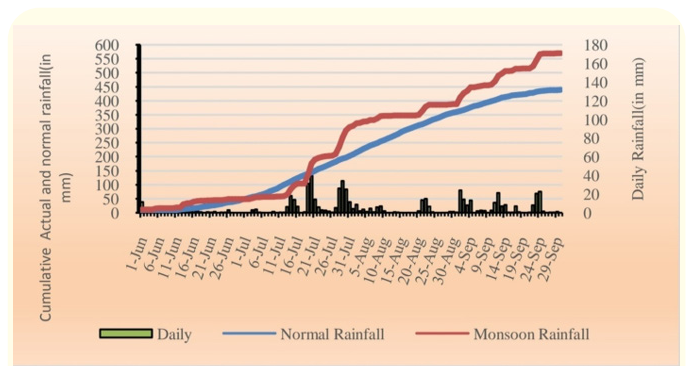


Figure 2: Daily cumulative Monsoon rain fall Haryana 2021.



Figure 3: a: A farmer’s rice field in Karnal-Haryana. On the left, rampant weed growth using traditional DSR method. On the right, the same field using DSR and Improved TAR VATTAR DSR technologies with delayed first irrigation at 15-20 days after sowing. (Photo by V.S. Lather). b: Weeds Free Tar Vattar DSR at Farmers fields in NW-India



Figure 1: Improved TAR VATTAR DSR TECHNOLOGY.



Figure 4: Weeds Free TAR VATTAR DSR.

Date of sowing: 2nd half of may 2022, no application of post emergence herbicides a: Udham Sing Nagar b: Bhiwani c: Karnal

through rains is also enhanced due to non-formation of hard layer at sub soils levels in the fields. The incidence of pest and diseases is also less. This Eco-friendly cropping system will also make other summer crops soybean, maize, sorghum, pigeon pea etc. to be weed free by managing the climatic factors and without application of post emergence weed killer.

Conclusions

In the modified TAR VATTAR DSR, the sowing of seeding recommended on TAR VATTAR fields (good moisture fields) during dry and hot climate of NW-India (20th May to 10th June) in irrigated zones when avg. temperatures are high and humidity very low (less than 30%) with application of pre- emergence weed killer immediately after the sowing and further delayed first irrigation at 15-25 days which make the DSR crops nearly weed free and need no application of post emergence weed killer. This Eco-friendly cropping system will also make other summer crops soybean, maize, sorghum, pigeon pea etc. to be weed free by managing the climatic factors and without application of post emergence weed killer.

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