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B Mohanta
Scientist (Agricultural
Engineering), KVK Bhadrak,
Sarasatia, Odisha, India

SK Mohanty
Senior Scientist & Head, KVK
Bhadrak, Sarasatia, Odisha, India

B Dhinda
Senior Research Fellow, NICRA
Project, KVK Bhadrak, Sarasatia,
Odisha, India

PJ Mishra
DEE, Odisha University of
Agriculture & Technology,
Bhubaneswar, Odisha, India

A Phonglosa
JDE, DEE, Odisha University of
Agriculture & Technology,
Bhubaneswar, Odisha, India

Mechanized line sowing of flood tolerant rice Swarna sub- 1 and its efficacy in climate resilience in Bhadrak District

B Mohanta, SK Mohanty, B Dhinda, PJ Mishra and A Phonglosa

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Abstract

Rice is the major crop of Odisha with a total 41 lakh ha which is about 65% of the total cultivable area of the state. Area under rice crop in Bhadrak district is 1,65,598 ha. Flash flood and submergence is a frequent incident in Paddy grown in rainfed lowland areas of Dhamnagar Block of Bhadrak District, causing damage to paddy crop grown during Kharif. Therefore, Krishi Vigyan Kendra, Bhadrak has introduced submergence tolerant paddy variety Swarna sub-1 through demonstration programme during Kharif 2023 and 2024 in the NICRA adopted village- Fatepur of Dhamnagar block. The demonstration includes scientific cultivation practices with mechanized line sowing of the rice seeds. The field was submerged for a period of seven days and six days during 2023 and 2024, respectively. The paddy productivity and economic return under improved technologies were calculated and compared with the prevailing farmers' practice of transplanting. The results revealed that line sowing of Swarna sub-1 variety recorded at par yield with farmers practice during the year 2023 and 2024 and the recommended practice gave higher net returns of Rs 52,470 and Rs 54,910 per ha and B:C ratio of 2.26 and 2.38, respectively as compared to farmer's practice.

Keywords: Swarna Sub 1, mechanized line sowing, flood tolerant rice, yield

Introduction

Rice (*Oryza sativa*) is the staple food of more than 50% of the world's population. Rice is the major crop of Odisha with a total 41 lakh ha which is about 65% of the total cultivable area of the state. Area under rice crop in Bhadrak district is 1,65,598 ha. Bhadrak district is situated in North Eastern Coastal plain Agroclimatic zone. Manual puddled transplanted rice (PTR) system is still the predominant method of rice establishment. However, due to declining water tables, increasing water scarcity, water, labor- and energy-intensive nature of PTR, high labor wages, adverse effects of puddling on soil health and succeeding crops, and high methane emission, this production system is becoming less profitable. These factors trigger the need for an alternative crop establishment method. The direct-seeded rice (DSR) technique is gaining popularity because of its low input demand compared to PTR. DSR offers advantages in water usage, labor, energy, emissions, and cost savings, but its adoption among farmers remains limited.

India holds second position in rice production after China (GRiSP 2013) [8]. India has the biggest area dedicated to rice farming at 44.4 Mha and having a historical yield of 122 Mt between 2020 and 2021, (USDA 2021) [16]. As a staple food, rice is vital to both India's food security and economic development. According to Mohanty and Yamano (2017) [12], more than one-fourth of the calorie intake comes from rice. Jha *et al.* (2012) [9] stated that the Eastern part of India has fallen behind the rest of the country in terms of rice production as well as farmer wealth. This may be due to the obstacles such as flood, drought, salinity levels, and poor fertility of soil, with incorrect or inadequate fertiliser application (Singh and Singh 2000) [13]. About 69% of the land is cultivated for rice, which accounts for 63% of the land that is used to grow food. Dar *et al.* (2017) [6] stated that Odisha is one of the largest producers of rice in eastern India. Odisha produces a large portion of its rice on sparsely populated tiny plots of land with different crop management techniques and restrictions.

Corresponding Author:
B Mohanta
Scientist (Agricultural
Engineering), KVK Bhadrak,
Sarasatia, Odisha, India

Because of this, rice directly affects the economy of the state, availability of food, nutritional status, and efforts to reduce poverty.

Compared to TPR, direct seeded rice (DSR) promotes mechanization which helps to decrease women's labour, workforce, production expenses, and the energy use (Kumar and Ladha 2011; Gathala *et al.* 2014; Laik *et al.* 2014) [10, 7, 11] while preserving as much as 30% of the total cost of production (Alam *et al.* 2018) [1], between 30 and 50% of the water used for irrigation, and other resources (Chaudhary *et al.* 2022) [2]. The DSR technology lowers tillage, prevents puddling-related soil structure loss, and lessens the need for labour while enabling prompt establishment of crop (Kumar and Ladha 2011) [10]. Farmers are gradually switching from the TPR system to the DSR system for all these great reasons (CSISA 2017) [4].

Studies have shown that DSR reduces water usage up to 30% or more, which is particularly important in regions that are already facing water scarcity or experiencing drought conditions due to climate change. By conserving water, DSR not only contributes to the sustainability of rice farming but also helps in preserving precious water resources for other agricultural and human needs. Flooded rice fields are responsible for a significant portion of global methane emissions, making rice cultivation one of the contributors to climate change. DSR fields are not continuously flooded, the anaerobic conditions that promote methane production are significantly reduced. Research has shown that DSR can lead to a 40% to 60% reduction in methane emissions compared to traditional flooded rice cultivation. DSR, on the other hand, improves soil health by reducing the anaerobic conditions that degrade soil structure. The absence of continuous flooding allows soil to maintain better aeration, which improves soil microbial activity and organic matter retention. This, in turn, helps sequester more carbon in the soil, contributing to carbon dioxide removal from the atmosphere. By improving soil health and reducing the need for chemical inputs, DSR enhances the long-term sustainability of rice farming.

The process of sowing seeds directly into the field is less labor-intensive and reduces cost of cultivation. One of the most significant benefits is the reduction in labor requirements. Transplanting rice seedlings is a labor-intensive task that requires a large workforce, especially during the peak season. DSR eliminates the need for transplanting, reducing labor costs and making rice farming more attractive to small-scale farmers, particularly in regions with labor shortages.

Materials and Methods

The study was conducted in National Innovations in Climate Resilient Agriculture (NICRA) adopted village- Fatepur, Block Dhamnagar, Dist- Bhadrak of Odisha in the Kharif season of 2023 and 2024. Rice var. Swarna sub -1 having submergence tolerance capacity was taken for the study. Swarna-Sub1 is a flood-tolerant rice variety developed by the National Rice Research Institute (NRRI) and released in 2009. It is a semi-dwarf variety that can withstand complete submergence for up to 14-17 days by using a gene (Sub1) that causes it to pause its growth during floods. It has field tolerance to major pests and diseases and it matures in about 140-145 days and high yielding. The soil of the study area is alluvial. The components of the demonstration program were improved variety Swarna sub- 1 seeds, seed treatment, proper tillage practices, mechanized line sowing, soil test based fertilizer application and plant protection measures. Training programs and field days have been conducted during the demonstration program. Total 20 ha area covered in two consecutive years. The crop was sown during the

first and second week of June. The yield data was collected from both the demonstration plot and farmers practice plot by random crop cutting methods. The data on crop yield was recorded per twenty-five square meter observation method and collected randomly from 3-4 places both for demonstrations and farmers field as described by Phonglosa *et al.* the average data were collected from both the demonstration and farmers field.

Observations on different growth and yield parameters were taken and economic analysis was done by calculating the cost of cultivation, gross return and net return. The gross return was calculated based on the prevailing minimum standard price fixed by Government. the field photographs of the demonstration program is given in Fig.1 and Fig. 2.



Fig 1: Mechanized line lowing of Swarna sub- 1



Fig 2: Line sown Rice variety Swarna Sub- 1

Results and discussion

Yield

The yield economics of the farmers practice and recommended practice of rice in Bhadrak district is presented in Table 1. Rice yield ranged from 38 q/ha to 40 q/ha in demonstration plots and 38 to 40 q /ha in farmers practice plot in two years demonstration during the Kharif 2023 and Kharif 2024. The average yield of rice during two years was 38.9 q/ha under demonstration plots and 39.6 q/ha farmers practice. The result indicated that the average yield in both cases are at par.

The observation parameters of stress tolerant rice variety Swarna Sub-1 like hill length, no. of tillers per hill and no. of panicle per tiller etc. is given in Table 2.

Table 1: Comparison of Yield economics of Swarna Sub-1

Year	Area	No. of farmers	Average Yield(q/ha)	
			Demo	Farmer's Practice
2023	10 ha	30	38.5	39.4
2024	10 ha	30	39.2	39.8

Table 2: Growth attributes of stress tolerant rice variety Swarna sub- 1

Year	Av. Hill length(cm)	Av. No. of tillers per hill	Av. Panicle length(cm)	Av. No. of grains per panicle
2023	112.5	17	24.2	205
2024	113	18	23.8	208

Table 3: Comparison of economics under FLD on improved rice variety Swarna sub- 1

Year	Cost of cultivation (Rs/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		B:C	
	FP	Demo	FP	Demo	FP	Demo	FP	Demo
2023	48,600	41,600	90,620	88,500	42,020	46,900	1.86	2.12
2024	47,950	39,850	93,840	90,160	45,890	50,310	1.95	2.26

Economic return

The average net return of demonstrated line sowing of rice Var. Swarna Sub 1 was higher than the farmers practice of transplanting (Table 3.). the benefit cost ratio under improved cultivation practices were 2.12 and 2.26 as compared to 1.86 and 1.95 under farmers practice for the year 2022 and 2023 respectively.

The higher yield may be due to proper plant population and scientific improved management practices.

Conclusion

Swarna sub- 1 is a very good flood tolerant rice variety suitable for the submergence condition of the Bhadrak district and the yield of line sowing of the Swarna sub- 1 result was at par the result of farmers practice. The net return from the demo is Rs 46900/- and Rs 50310/- per ha for the year 2022 and 2023 respectively. The benefit cost ratio under improved cultivation practices for the year 2022 and 2023 is 2.12 and 2.26 respectively. The technology has a greater impact among the farming community for horizontal spread.

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