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Performance of Submergence Tolerant Shallow Lowland Rice Variety Swarna *sub-1* under Frontline Demonstrations in East and South Eastern Coastal Plain Zone of Odisha, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Frontline demonstrations on rice crop in 15.4 ha area using submergence tolerant variety Swarna *sub-1* were carried out in participatory mode in farmers' field during *Kharif* season of 2016, 2017 and 2018 at Ranapur village of Khordha district under East and South Eastern Coastal Plain Zone of Odisha by University Extension Block programme (UEBP) of Odisha University of Agriculture and Technology, Odisha, India. Major constraints of traditional rice cultivation are low productivity in shallow lowland areas due to lack of knowledge and partial adoption of recommended package of practices by rice growing farmers. Therefore, present demonstration programmes have been undertaken to popularize/introduce stress tolerant rice var. Swarna *sub-1* in flood prone and shallow lowland areas of Khordha district of Odisha, India. The present study revealed that there was 20.4% increase in average yield of demonstrated field over the farmers practice field of rice crop. An average yield of 45.68 q ha^{-1} was recorded in demonstration as compared to 37.84 q ha^{-1} in farmers practice during consecutive three years demonstrations. It might be due to considerable variation in the extent of adoption of improved/recommended technology which was resulted lower yield in farmers practice. Average technology gap, extension gap and technology index was found 12.32 q ha^{-1}, 7.84 q ha^{-1} and 28.39%, respectively. The demonstrations with improved practice gave higher net return of Indian Rupee (INR) 18180, 26538 and 35605 ha^{-1} as compared to farmers practices

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with INR 12987, 16361 and 17294, respectively during *Kharif* seasons of 2016, 2017 and 2018. The benefit cost ratio (B:C ratio) of rice cultivation under improved practices were found to be 1.42, 1.60 and 1.80 as compared to 1.31, 1.38 and 1.39 under farmers practices. Moreover, the demonstration practice showed maximum 105.88% increase in net returns over farmers practice.

Keywords: Rice yield; submergence tolerant; swarna sub-1; frontline demonstrations; Odisha.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for about half of the global population, grown in 160 million ha (M ha) with 493 million tons (Mt) milled rice production [1,2]. The population of the country is burgeoning, which may stabilize around 1.4 and 1.6 billion by 2025 and 2050, requiring annually 380 and 450 mt of food grains, respectively [3]. In India, rice is grown in 43 million ha area with production of 112 million tons of milled rice and productivity of 2.6 t ha^{-1} [4]. Hence, increasing productivity and keeping pace with the rising food demand with minimal environmental disturbance has become a challenge to the farmers and scientists. Odisha is one of the main rice producing states in Eastern India [5], but average rice yields in Odisha are distinctly lower than the national average [6]. In Odisha, most of the rice is cultivated in small landholdings in different ecologies with varying crop management practices and constraints such as drought and floods, which influence the rice yields and the need for supplemental nutrients [4]. Mostly the farmers of Khordha district of Odisha are growing medium and long duration (140 - 155 days) rice varieties as irrigated and rainfed crop. The popular rice varieties like Gayatri, Puja, Swarna, Geetanjali, Pratikshya, CR-1009 etc. are mostly grown in the low land area of the district. Swarna *sub-1* has high production potential and can tolerate waterlogged condition. Moreover, the improved agronomic practice knowledge of the farmers about the improved high yielding varieties and adoption of proper package of practices are also the reasons responsible for limiting and low productivity of rice. Keeping this in consideration, University Extension Block programme (UEBP) under Odisha University of Agriculture and Technology had taken up demonstrations to popularize/ introduce stress tolerant rice var. Swarna *sub-1* in flood prone and shallow low land areas of East and South Eastern Coastal Plain Zone of Odisha, India.

2. MATERIALS AND METHODS

Frontline Demonstrations (FLDs) in rice were carried out in participatory mode in farmers' field during *Kharif* seasons of 2016, 2017 and 2018 at Ranapur village of Khordha district by University Extension Block programme (UEBP), Odisha University of Agriculture and Technology, Odisha, India. The foundation seed of improved rice variety Swarna *sub-1* was procured from seed production farm of Odisha University of Agriculture and Technology, Odisha for demonstration purpose. This variety is a semi dwarf (105-110 cm) and long duration variety (145 days) under transplanted condition. It was released during 2009 in India by National Rice Research Institute, Cuttack, Odisha and Narendra Dev University of Agriculture and Technology (NDUAT), Kumarganj, Faizabad, Uttar Pradesh, India. It can tolerant complete submergence for 14 to 17 days because of presence of *Sub-1* gene. Under longer submergence (10 days or more), Swarna *sub-1* look withered and dead after receding of water, but due to presence of *Sub-1* gene resulting rapid generation of new tillers and faster crop recovery as compared to other rice crop varieties. A total of 35 demonstrations in 15.4 ha area were conducted in the selected villages of Khordha district. In local check plots, existing practice of transplanting with rice variety Swarna was followed by the farmers. The complete package of practices approach demonstrated in farmers field through FLDs including improved variety, recommended seed rate, seed treatment, sowing method, fertilizer dose, weed management and plant protection which are presented in Table 1. All inputs including seeds, fertilizers, pesticides, weedicides etc. were used in the demonstrated plots whereas the farmers' practices plots were devoid of these improved practices. Different data *viz.* number of matured panicles m^{-2}, number of filled grains per panicle, test weight (g) and grain yield (q ha^{-1}) were collected from different demonstrations for three years. The farmers involved in demonstrations were facilitated by UEBP scientists in performing proper field managements like timely sowing of nursery in bed, transplanting of seedling, spraying of weedicide and insecticides and harvesting of crops. During the growing period of rice, different extension activities like farmers' training, diagnostic visits, soil health day, field

Table 1. Improved practices and farmers practices of rice under Frontline Demonstrations

Sl. No.	Particulars	Improved practices for demonstration	Existing Farmer practices	GAP
1	Variety	Swarna *sub-1*	Pooja, Swarna	Full gap
2	Field preparation	Ploughing, Harrowing and puddling	Ploughing, Harrowing and puddling	-
3	Seed rate	50 kg ha^{-1}	70 kg ha^{-1}	High seed rate
4	Seed treatment	Tricyclazole 75WP @ 2g kg^{-1} of seed	No seed treatment	Full gap
5	Nursery management and transplanting	Nursery seeding is done during May to June and transplanting is done during July	Nursery seeding is done during May to June and transplanting is done during July	-
6	Sowing method	Line transplanting	Random transplanting	Full gap
7	Fertilizer dose	NPK @ 80:40:40 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + well decomposed FYM @ 5 t ha^{-1}	Imbalance use of fertilizer/ Without recommendation	Partial gap
8	Weed management	Bispyribac Sodium 10% + Clomazone 48%@ 0.25 litre ha^{-1}	Butachlor @ 2.0 litre ha^{-1}	Partial gap
9	Plant protection	Need based plant protection measures	Injudicious use of plant protection chemicals	Full gap

days etc. were undertaken which benefited the farmers of the district. The average data were collected from both the demonstrations and farmers' fields. Data on crop yield were recorded per twenty five square meter observation method and collected randomly from 3 to 4 places both for demonstrations and farmers fields. Average collected data of three years were analysed using simple statistical tools. The technology gap, extension gap and technology index, according to Samui et al. [7] were calculated using the formulae given below:

$$\text{Technology gap} = \text{Potential yield} - \text{Demonstration yield}$$

$$\text{Extension gap} = \text{Demonstration yield} - \text{Farmers'practice yield}$$

$$\textbf{Technology index}\ (\%) = \frac{\textbf{Potential yield} - \textbf{Demonstration yield}'}{\textbf{Potential yield}}\ \textbf{x 100}$$

3. RESULTS AND DISCUSSION

3.1 Yield

The yield data indicated that due to frontline demonstration, rice yield ranged from 39.90 q ha^{-1} to 51.70 q ha^{-1} in demonstration plots and from 35.61 q ha^{-1} to 39.50 q ha^{-1} in farmers practice plot in three years demonstrations during *Kharif* 2016, 2017 and 2018 (Table 2). The result revealed that average yield of rice through FLDs during three years was 45.68 q ha^{-1} under demonstration plots as compared to 37.84 q ha^{-1} in farmers practice plots. This result clearly indicated the higher average yield in demonstration plots over the years compared to farmers practice was due to knowledge and adoption of improved practices. The yield enhancement due to the improved practices ranged between 12.0 to 30.9 percent over farmers' practice. The percent increase in yield over farmers' practice was highest during *Kharif*-2018 (Table 2). Similar findings in rice and others crops have been reported by Mishra et al. [8], Pandey et al. [9] and Goswami et al.[10]. Yield attributes of improved practices indicated that the number of matured panicles per square meter, number of filled grains per panicles and test weight (g) were 265-290, 158-198 and 24.5-26 as compared to 198-210, 110-125 and 23.5-25 under farmers practice (Table 3).

3.2 Technology Gap

The technology gap, the differences between potential yield and yield of demonstration plots was 18.10, 12.55 and 6.30 q ha^{-1} during *Kharif* 2016, 2017 and 2018, respectively. Average data indicated that technology gap under three years FLDs programme was 12.32 q ha^{-1} (Table 4). This may be due to the soil fertility status, agricultural practices, local climatic situation and may overcome by adopting efficient management practices.

Table 2. Yield performance of rice variety Swarna *sub-1* and farmers' practice during *Kharif* seasons of 2016, 2017 and 2018

***Kharif* season**	**No. of Demonstrations**	**Area (ha)**	**Demo yield ($q\ ha^{-1}$)**	**Farmers practice yield ($q\ ha^{-1}$)**	**Yield increase over farmers practice (%)**
2016	5	0.4	39.90	35.61	12.0
2017	10	5.0	45.45	38.42	18.3
2018	20	10.0	51.70	39.50	30.9
Average	11.67	5.13	45.68	37.84	20.41

Table 3. Performance of yield attributes of rice var. Swarna *sub-1* and famers' practice during *Kharif* seasons of 2016, 2017 and 2018

Yield attributes	**Demonstration**	**Farmers' practice**
No. of matured panicles m^{-2}	265-290	198-210
No. of filled grains $panicle^{-1}$	158-198	110-125
Test weight (g)	24.5-26	23.5-25

Table 4. Impact assessment of rice var. Swarna *sub-1* on technology gap, extension gap and technology index

***Kharif* season**	**Technology gap ($q\ ha^{-1}$)**	**Extension gap ($q\ ha^{-1}$)**	**Technology index (%)**
2016	18.10	4.29	45.36
2017	12.55	7.03	27.61
2018	6.30	12.20	12.19
Average	12.32	7.84	28.39

3.3 Extension Gap

In the present frontline demonstration, the extension gap of 4.29, 7.03 and 12.20 q ha^{-1} was observed during *Kharif*-2016, 2017 and 2018, respectively. On an average extension gap under three year frontline demonstration programme was observed to be 7.84 q ha^{-1}. This extension gap necessitates the need to bring awareness among the farmers for adoption of improved stress/flood tolerant rice varieties. These findings are in similarity with Goswami et al. 2020 [10] and Singh et al. 2018 [11].

3.4Technology Index

“It refers to the ratio between technology gap and potential yield expressed in percentage”. The technology index shows the feasibility and performance of the demonstrated technology at the farmers’ field. The lower value of technology index shows the efficacy of good performance of technological interventions. In present demonstration, the technology index varied from 12.19 to 45.36 per cent (Table 4). Similar findings were reported by Girish et al. [12]. The average technology index was recorded as 28.39 per cent in rice crop during the three consecutive years of demonstration programmes. Technology index can be reduced with proper adoption of demonstrated technological interventions to increase the yield potential of rice crop. It shows the effectiveness and good performance of technological interventions.

4. ECONOMIC RETURN

The cultivation of stress tolerant rice variety Swarna *sub-1* gave higher net return of Indian Rupee (INR) 18180, 26538 and INR 35605 ha^{-1} , respectively as compared to farmers practices with INR 12987, 16361 and 17294 ha^{-1} , respectively during *Kharif* season of 2016, 2017 and 2018 (Table 5). The benefit cost ratio (B:C ratio) of rice cultivation under improved practices were found to be 1.42, 1.60 and 1.80 as compared to 1.31, 1.38 and 1.39 under farmers practices. The economic viability of improved demonstrated technology over existing farmers practice was calculated depending on prevailing price of inputs and outputs cost and it was expressed in the term of B:C ratio. The additional cost increased in demonstration was mainly due to more cost involved in balanced fertilizer, purchase of seed and herbicides. In the present

Table 5. Economic analysis of improved practice and farmers' practices

***Kharif* season**	**Demonstration**					**Farmers practice**			
	Cost of cultivation (INR ha^{-1})	**Gross return (INR ha^{-1})**	**Net return (INR ha^{-1})**	**B:C ratio**	**Increase in net returns over farmers practice (%)**	**Cost of cultivation (INR ha^{-1})**	**Gross return (INR ha^{-1})**	**Net return (INR ha^{-1})**	**B:C ratio**
2016	43420	61600	18180	1.42	39.99	41990	54977	12987	1.31
2017	43910	70448	26538	1.60	62.20	43190	59551	16361	1.38
2018	44530	80135	35605	1.80	105.88	43931	61225	17294	1.39

Note: INR=Indian Rupee; B:C=Benefit cost ratio demonstration, increase in net returns over farmers practice varied from 39.99 to 105.88 per cent. The improved practices showed maximum 105.88 per cent increase in net returns over farmers practice during *Kharif* season of 2018. This may be due to higher yield obtained under improved practices compared to farmers practice. These results are also in conformity with the findings of Singh et al. [11] and Girish et al. [12].

5. CONCLUSION

Based on three years of frontline demonstrations, it can be concluded that the yield potential of rice cultivar under stress condition increased to a great extent by adopting frontline demonstrations of established technology. The frontline demonstration had a greater acceptance with improved practices and resulting higher profitability for the farming community under flood prone and shallow lowland areas of Odisha. Thus, it is recommended that the improved practice needs to be popularized to decrease the technology gap, extension gap, technology index and there by yield gap so as to increase the income of farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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