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Improvement of rice yields in the Mancherial district of Telangana with the use of the STCR targeted yield strategy

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Abstract
Across all districts in Telangana State, rice is the main crop that is widely grown, making up 26.62% of the total planted area during both the *Kharif* and *Rabi* seasons. Crops grown in the Mancherial area are mostly cotton, with rice coming in second. District yields are lower on average than state yields. A crucial ingredient that directly impacts crop yields and cultivation costs is fertilizer. Using the intended yield equation and soil test data, Krishi Vigyan Kendra (KVK), Mancherial performed an on-farm trial in five different locations over the course of three years, in the kharif seasons of 2019, 2020 and 2021. The treatments consist of the farmer's practices, the RDF-120-60-40 NPK kg ha^{-1} recommended fertilizer dosage, and STCR-based fertilizer recommendations with a 60 q ha^{-1} production objective. The first soil samples that were taken and examined revealed that the soils had a low accessible nitrogen content, a high P content, and a medium K content. The amount of N, P, and K fertilizers added in accordance with the results of the first soil test and the target yield equation. The findings demonstrated that, during the course of the experiment, greater yields were noted in the STCR treatment, which was followed by farmer practice and RDF. When fertilizers are applied using the targeted yield equation and the STCR, yields can rise by up to 11.5% when compared to traditional farming methods. The usage of fertilizer dosages was decreased by the use of STCR-based treatments, saving money on inputs with good net returns and a favorable B:C ratio.

Keywords: Yield, soil test crop response, rice

Introduction
One of the most significant staple food crops in Asia, particularly in India, is rice (*Oryza sativa* (L.). It is one of the main crops that is widely grown in all of Telangana State's districts during both the *Rabi* and *Kharif* seasons. Rice production in the state of Telangana, which covers an area of roughly 14.19 lakh hectares, has increased significantly over the last three years, from 2.84% of the country's total production in 2015–16 to 5.54% in 2017–18. Rice is the second most important crop grown in the Mancherial district, after cotton. The availability of water resources has led to an expansion in the area under paddy in recent years. One of the most expensive agricultural inputs is fertilizer, and using the proper amount at the correct time is essential to both environmental preservation and farm profitability (Kimetu *et al*., 2004) [7]. By eliminating overuse or underuse of fertilizer inputs, soil test-based fertilizer prescription increases crop output and fertilizer use efficiency.
Insufficient understanding of the soil and crop requirements leads to the wastage of expensive inputs like as pesticides, water, fertilizers, and other inputs, which has a negative impact on the environment and causes financial loss. India has seen a lot of interest in balanced NPK fertilization (Gosh *et al*., 2004; Hegde *et al*., 2004) [4, 5]. Farmers can better employ fertilizers based on crop demands thanks to soil testing. The strategy known as "fertilizer use for targeted yield" (Ramamoorthy *et al*., 1967) [8] considers both the nutrients in the soil and the demands of the crop.

Integrated fertilizer recommendations are critical in intensive agricultural systems because they balance soil and apply nutrients from both organic and inorganic sources to improve soil health and crop nutrition.

In order to increase yield, farmers are using excessive amounts of chemical fertilizers; nevertheless, choosing which fertilizers to use depends on understanding crop output expectations and how crops will react to nutrient treatment. According to Dobermann *et al*. (2003) [3], it depends on the crop's nutritional requirements, the availability of nutrients from native sources, and the short- and long-term outcomes of the applied fertilizer nutrients. One of the causes of decreased output is farmers' uneven application of fertilizers, which has negative effects on the soil and crops in terms of nutrient toxicity and insufficiency since they don't know the state of the soil's fertility or the crops' nutritional requirements (Ray *et al*. 2000) [9]. The fertilizer prescription equations for various crops in various agro-ecological conditions across many states were created by the AICRP center of the STCR project. We obtain the specific fertilizer nutrient recommendation by substituting the soil test values and goal yield into the prescription equations. This has to be transformed into the amount of fertilizer that needs to be administered. In addition to conserving fertilizer and boosting the economics, these fertilizer target yield equations will also assist to promote soil health. The application of fertilizers based on the STCR equation will cause an accumulation of nutrients in the soil, according to Srinivasan and Angayarkanni (2008) [10]. Higher response ratios and benefit: cost ratios can be achieved by the delivery of plant nutrients based on soil tests. In light of this, the current study analyzed farmers' practices and recommended fertilizer application doses using the STCR approach to fertilizer application with targeted yield.

Materials and Methods

In order to increase the yield of the rice crop in the district with the targeted yield fertilizer application compare to RDF and farmer's practice, Krishi Vigyan Kendra, Bellampalli, Mancherial district under Professor Jayashanakar Telangana State Agricultural University conducted on-farm trials on STCR based fertilizer application in rice during the years 2019 through 2021 in five farmer locations of different villages in the Mancherial district. AICRP's equation on STCR rice, appropriate for the Northern Telangana Zone, was used to determine the target yield of 60 q ha^{-1}. The amount of fertilizer needed to reach the target yield was then computed based on the initial soil fertility state.

STCR based fertilizer application

Fertilizer Nitrogen (FN) = 3.78T-0.44SN
Fertilizer Phosphorus (P_2O5) = 1.96T- 2.13SP
Fertilizer Potassium (K_2O) = 2.96T-0.36SK

Where
N, P_2O_5, and K_2O are fertilizer N, K_2O, and FN, respectively, in kg per hectare. SN, SP, and SK represent soil accessible N, P, and K in kg ha^{-1}, respectively; T is the target yield in q ha^{-1}.

The recommended fertilizer dosage (RDF), the farmers' fertilizer practice (T_1), and the soil test crop response (STCR)-based fertilizer dose (T_3) are the three treatments that aim to achieve a yield objective of 60 q ha^{-1}. In order to assess the alkaline $KMnO_4$-N (Subbiah & Asija, 1956) [13], Olsen-P (Olsen *et al*., 1954) [14], and NH_4OAc-K (Hanway & Heidal, 1952) [15], initial soil samples were taken in each site. Through adjustment equations and fundamental data collected from fertility gradient field trials for paddy, the available status of nutrients was used to determine fertilizer dosages for the crop. According to Valayutham *et al*. (1985) [16], a thorough process has been outlined.

Four splits were used to apply the necessary nitrogen: 25% at basal, 25% at tillering, 25% at active tillering, and the last dosage at the panicle initiation stage. Phosphorus and potassium were administered as basal.

Results and Discussion

Table 1: Based on STCR, RDF, and farmer practices in 2019, 2020, and 2021, yield and yield characteristics of the targeted yield (60 q ha^{-1})

S. No	Number of tillers m^{-2}			Number of panicles m^{-2}			Number of grains $panicle^{-1}$			Yield (kg ha^{-1})		
Year	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
2019	576	554	590	554	533	572	172	166	190	5352	4932	6091
2020	512	440	540	446	398	524	154	142	176	5049	4679	5825
2021	498	486	560	464	448	532	198	186	212	5462	5197	6018
Mean	529	493	563	488	460	543	175	165	193	5288	4936	5978

Targeting optimal rice yield

The yield characteristics of the various treatments as well as their yield year are displayed in Table 1. It is evident that the three years of better rice output (mean 5978 kg ha^{-1}) above the farmers practice and RDF was mostly due to the shown targeted yield based fertilizer application of 60 q ha^{-1}. The reason for the mean increase in tiller counts (590, 540, and 560) with mean values of 529, 493, and 563 in 2019, 2020, and 2021, respectively, from treatment T_3 may be attributed to the plant's increased ability to divide and elongate its cells, as well as various metabolic processes that ultimately increased the number of tillers along with source capacity (Jha *et al*., 2006) [6]. Similarly, the order $T_3>T_1>T_2$ was followed by the maximum number of panicles m-2 and the number of grains $panicle^{-1}$. Number of panicles m^{-2} (488, 460, and 543) and number of grains $panicle^{-1}$ (175,165, and 193) are the average values. The application of fertilizers based on targeted yield may have increased the availability of soil nutrients due to higher fertilizer application as per crop requirements, which may have contributed to the increase in grain yield (6091 kg ha^{-1}, 6025 kg ha^{-1}, and 6018 kg ha^{-1}) with mean values of 5978 kg ha^{-1}. These results are consistent with Subramoney and Padmanabhan Nambiar's (1969) [11] findings. Additionally, supplementation may have increased the availability of macronutrients during the stages of crop peak requirements (Chandrasekarappa, 1985) [2].

The field experiment yielded data on the amount of nutrients needed to create a quintal yield as well as the percentage of nutrients that came from soil and fertilizers. These were calculated using several techniques. Tillering of rice is an essential aspect of growth from a physiological perspective. According to Bhairappanavar *et al*. (2022) [1], secondary roots in rice begin to emerge between the fourth and fifth leaf stage, whereas tillering starts at the third leaf stage. Table 1 provides the descriptive values for the number of tillers m^{-2}, number of panicles m^{-2}, number of grains $panicle^{-1}$, and grain yield (kg ha^{-1}) influenced by varying NPK application levels based on farmers'

fertilizer practice, RDF, and targeted yield based fertilizer application over three consecutive years. When fertilizers are applied using the targeted yield equation and the STCR, yields can rise by up to 11.5% when compared to traditional farming methods.

Table 2: Impact of RDF, STCR, and farmer practices on rice economics in 2019, 2020 and 2021

S. No	Cost of cultivation (Rs. ha^{-1})			Gross returns (Rs. ha^{-1})			Net returns (Rs. ha^{-1})			B:C ratio		
Year	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
2019	43200	39712	42871	95660	86310	104593	52460	46598	61722	2.27	2.17	2.48
2020	43479	41892	42742	91308	84583	100938	47829	42691	58196	2.06	2.07	2.33
2021	45785	42180	43666	99949	95526	110136	54164	53346	66470	2.18	2.26	2.52
Mean	44154	41264	43093	95638	88809	105222	51484	47545	62129	2.17	2.16	2.44

Economics

Targeted yield response in paddy as influenced by various treatments, as measured by revenue data (Table 2) According to the findings, T_1 farmers' fertilizer practice has the highest mean cost of cultivation at Rs. 44,154, followed by T_3 farmers' fertilizer practice at Rs. 43,093. Conversely, the treatments with the highest mean gross returns were T_3 (Rs. 1,05,222), T_1 (Rs. 95,638), and T_2 (Rs. 88809). Comparably, T_3 had the greatest net returns and B:C, with a mean of Rs. 62,129 and 2.44; T_1 came in second with Rs. 51,484 and 2.17; while T_2 yielded the lowest returns, with a mean of Rs. 47,545 and 2.16. The maximum yields may result from more productively applying nutrients at the appropriate time and dose, as demonstrated by Sonune *et al*. (2003) [12].

Conclusion

The outcomes revealed that, over the course of the experiment, the STCR treatment yielded the highest yields, which were then followed by farmer practices and RDF. When fertilizers are applied using the targeted yield equation and the STCR, yields can rise by up to 11.5% when compared to traditional farming methods. By reducing the amount of phosphotic fertilizer used, the adaptation of STCR-based treatments was able to save money on inputs with good net returns and a favorable B:C ratio.

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