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Impact of Green manuring preceding to rice crop on rice yield and cost of cultivation in Nizamabad District of Telangana state

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ABSTRACT

Field experiments were conducted at farmer's fields on the application of green manure Dhaincha (Sesbania rostrata) as preceding crop to rice to improve yields with green manuring and also increase the status of soil physical and chemical properties, soil organic carbon and pH towards neutral. The performance of an entire system is evaluated by front-line demonstration under the control of Krishi Vigyan Kendra, Nizamabad (Rudrur) under field conditions at s farmer's field. Sesbania seeds were sown @ 45-50 kg/ha. 5-6 weeks old green manuring crops were chopped into pieces and incorporated in the fields with a tractor drawn rotovator. With the incorporation of green manure crops, the average rice yield was increased by 8.36%.

The demonstration was done on around 8 hectares covering 20 rice-cultivating farmers. During 2019-21 years with conventional practice, three years average no. of panicles per meter square was only 173 whereas it was 182 in the demonstration plot, similarly, the average grain yield was 6467 kg/ha and 7008 kg/ha in farmer's practice and demonstration plots respectively.

The average net return was only Rs.67,092 per hectare from farmer's practice, whereas it with the incorporation of green manure crop before rice was Rs.82,310 in demonstration plots respectively. Similarly, the average cost to-benefit ratio was 2.24 in the conventional method and later it was noticed 2.69 in the demo plot. Hence, the farmers growing rice in the wetland ecosystem are advised to take- up green manure followed by transplanted rice as a cropping pattern for sustainable yield and economic returns.

Keywords: *Rice, Green manure, Yield, Available Nitrogen Content, Organic Carbon.*

Introduction

Rice (Oryza sativa L.) being one of the principal food crops, is the staple food of over half of the world's population. It is the basic food crop and being a tropical plant, it flourishes comfortably in hot and humid climates [20]. India has the largest area under rice cultivation, under this; rice is the second largest producer and consumer of rice in the world [21]. Rice is mainly grown in rain-fed areas that receive heavy annual rainfall. That is why it is fundamentally a *kharif* crop in India, however, is also grown through irrigation in those areas that receives comparatively less rainfall. Rice is one of the major cereal crops of East Kameng district of Arunachal Pradesh occupying an area of 8,968 ha with an average production of 13,631 MT and average productivity is 1520 kg/ha during 2013-14 which is far below the productivity of rice growing states of India and national average productivity [11].

Poor rice productivity in the district may be due to the use of age-old production practices. Moreover, farmers of the district are unaware of the improved packages and practices released by different research institutions and are not willing to use chemical fertilizer even if it is made available to them [19].

After the introduction of high-yielding varieties, it becomes essential to provide nutrients to enhance the productivity of rice. Front-line demonstrations were conducted to demonstrate the production potential of released proven technologies in farmer's fields under real farming situations and the available technologies should reach the farmers[15]. Indeed knowledge dissemination through the FLD programme has increased the level of knowledge among participant farmers as compared to non-participant farmers to a significant level [22] and [18]. This shows a positive impact of front-line demonstration on yield and knowledge of the farmers [23].

In India, rice is grown in almost half the states, with West Bengal leading the way in terms of production with 14.71 million tonnes, followed by Uttar Pradesh (12.22 million tonnes) and Andhra Pradesh (11.57 million tonnes). In Tamil Nadu rice is only the staple cereal crop, and rice growers have used a large

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amount of chemical fertilizer and herbicide to increase rice field's productivity. To increase agricultural production, in conventional agriculture chemical N fertilizers are often overused to such an extent that the environment is adversely affected. Concentrations of several reactive oxidized and reduced forms of N such as N_2O, NO_3, and NH_3 are reported to exhibit an increase in their concentrations in the environment [7] [13].

Green manuring with N-fixing legume crops can provide a substantial quantity of rice N requirement with organic matter to wetland rice soils. Additionally, this technology is safe for human health and environmentally friendly. The soil management practices to increase fertility and productivity should include an increase in biomass along with reducing its decomposition [3].

In the last few years, there have been several meetings and publications dealing with the broad perspectives of sustainable agriculture [6]. The basic thrust of sustainable agriculture is to improve the quality of life in the context of an environmentally sound approach so that the resource base is maintained or enhanced for future generations. There are frequently additional focuses on sustainability as [8]; defines that the "Sustainable agriculture should involve successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources". Similarly, it has been suggested by Agriculture Canada, [1] that the "Sustainable agriculture system are those that are economically viable to meet society's needs for safe and nutritious food, while conserving the quality of the environment for future generations".

Since the Green Revolution of the 1960's, substantial increases in cereal production have allowed an ongoing rise in world population, which now exceeds 6.5 billion. The gain in agricultural productivity has been accomplished with the introduction of modern crop production practices that rely on high- yielding varieties and heavy inputs of fertilizers and pesticides. This approach is solely directed towards maximizing grain yield, without regard to long- term impacts on the soil resource that is crucial for sustainable cereal production. Consequently, a dramatic escalation has occurred in global consumption of synthetic N, from 11.6 Tg in 1961 to 104 Tg in 2006 [9]. In many parts of the world, N fertilizer recommendations continue to follow a prescriptive approach using generic models of economic response, often without regard to site-specific variation in crop N requirement [14]. Given the fundamental coupling of microbial C and N cycling, the dominant occurrence of both elements in soil organic forms, and the close correlation between soil C and N mineralization [4], the loss of soil organic carbon has serious implications for the storage of soil N. There is good reason for concern about sustaining world food production and maintaining sustainability in soil productivity the present experiment was conducted.

Out of 2,68,650 ha of net cropped area of Nizamabad district of Telangana state maximum area i.e. 1,61,190 ha (2019-21) is under traditional rice, mostly cultivated as irrigated crop during *Kharif* season. The productivity of rice in the district is high due adoption of high-yielding varieties and other improved technologies and high fertilizers consumptions. Intending to improve rice production and productivity, KVK of Nizamabad district, conducted front line demonstration (FLD) Programme entitled "Demonstrationt of Green manuring preceding to rice crop" in twelve villages (viz. Rudrur, Hunsa, Suddulam, Lingampalli, Kollur, Hungarga farm, Raikur, Gannaram, Baswapur, Eklaspur, Minarpalli, Eklaspur villages) of three mandals in three consecutive years i.e. 2019-20, 2020-21 and 2021-22 in the farm land of farmers. Impact analysis of Front Line Demonstrations (FLD's) of rice on yield, economic returns, and adoption of demonstrated technology has been carried out.

Table 1: Average values of Some physical & chemical properties of soil used for the study

S.No	Parameter	0-6 inch depth
1	Soil pH	8.05
2	E.C (ds/m)	0.38
3	Organic Carbon (%)	0.426
4	Available Nitrogen (kg/ha)	200
5	Available Phosphorus (kg/ha)	45.3
6	Available Potash (kg/ha)	336.71

Materials and Methods

Field experiments were conducted in farmer's fields through front-line demonstrations (FLD's) during the *Kharif* season between 2019 to 2021 in twelve villages of three mandals (Rudrur, Kotagiri, and Bodhan) in Nizamabad District of Telangana with the active participation of farmers after different extension approaches through regular field visit and Awareness programs, pieces of training and interpersonal communication made by the scientists of Krishi Vigyan Kendra, Nizamabad (Rudrur). The soil of the study area was slightly acidic in reaction (pH 5.5 to 6.0), sandy loam in texture with low to medium in organic carbon content, medium to high in phosphorous, and medium to high range of potassium content.

Green manure in paddy fields

Seeds of green manuring crop (Dhaincha) Sesbania rostrata were sown during May using seed rates of 45-50 kg /ha, 5- 6 weeks old green manuring crops were chopped into pieces and incorporated in the soil with the help of a tractor-drawn rotovator. After that, the seedlings of rice were transplanted and followed all management practices in proper times starting from land preparation to crop harvest. Observations on different yield parameters were taken and economic analysis was done.

The soil was analyzed for organic carbon and available nitrogen at the end of each year after the harvest of rice. Tabular analysis involving simple statistical tools like

1. Extension gap =Yield through demonstration - Farmers practice yield

2. Effective gain = Additional return - Additional cost

3. Additional return =Return through FLDs - Return through Farmers' practices

4. Incremental B: C ratio = Additional return/ Additional cast

The technologies which will be directed to achieve the ends have not only to be physically and environmentally feasible but also economically viable.

Results And Discussion

Results of the Cluster Frontline Demonstrations conducted during 2019-20 to 2021-22 in different villages of Nizamabad district revealed that the Green manuring before rice crop improved the productivity and profitability of rice.

Growth and Development

The green manuring practice produced (Fig.2) higher plant

height (116.3 cm), grains per panicle (182), and test weight (16.35 g) in comparison to the farmers practice. This was in agreement with the findings of [10]. This shows a positive impact of front-line demonstration on the knowledge of the farmers.

Effect of green manuring on rice grain yield

Result of front line demonstrations on Green manuring of (Sesbania sps.) before rice produced significantly better grain yield of rice than the only chemical fertilizers applied plot. Maximum paddy yield of green manure incorporated fields 76.25 q ha^{-1}, 63.00 q ha^{-1}, and 71.00 q ha^{-1} produced during 2019, 2020 & 2021 years, respectively. Overall average yields of three years 70.08 q.ha^{-1} was produced. Sowing of Dhaincha as Green manure increased rice yield. This might be due to higher tillers and grain production.

Rice grain yields differed between farmers' practices and Demos, locations, and years (Table 4). The overall mean was 70.08 q ha^{-1} with a higher average yield.

The yield of farmer's practice ranged from 57.50 (2020) to 70.00 q ha^{-1} (2019) and Demo *i.e* green manuring preceding to rice at the rate of 45-50 kg ha^{-1} increased yields by 8.92%, 9.56% and 6.77 % respectively in the first, second and third years of green manure application.

The N application rate was much lower with green manure crop before rice compared to the farmer's practice, The rice yield response to green manure application showed a similar pattern (stronger response in 2020 than in 2019 & 2021) and was significant in both years.

Changes in Soil Fertility Status

The results of the study indicated that the use of green manuring crop incorporation proceeding to rice improved the physico-chemical status of the soil. The organic carbon status of the soil (Table 3) increased after the harvest of rice at the end of each year. The Green manure practice contributed to an average increase of 1.56% in organic carbon content after the harvest of rice for three years. Such an increase in organic carbon content is attributed to the accumulation of root residues and shedding of leaves by the leguminous crops. These results were in conformity with [2] and [19].

The initial available nitrogen status of the soil was 169.6, 208.58, and 223.2 during 2019-20, 2020-21 and 202122 years respectively an average of 200.46 kg/ha. An increase in available nitrogen status (average 0.58%) after each year was observed with the incorporation of dhaincha which could sustain soil fertility. Thus the FLD might have a positive impact on fertility [2] and [16].

Economics of demonstrated Technology

Different variables like seed, labor, bio-fertilizers, and pesticides were considered as cash inputs for the demonstrations as well as farmer's practice. The Effect of the demonstration was also observed in the economic front too (Table.4).

Results of economic analysis parameter revealed that the rice crop recorded higher gross returns of Rs.1,37,250/-, Rs.1,18,440/- and Rs.1,37,740/- per ha during 2019-20, 2020-21, and 2021-22, respectively under this Front Line Demonstration as compared to Rs.1,26,000/-, Rs.1,08,100/- and Rs.1,29,010/- per ha respectively under farmers practice (Table.4).

This demonstration had a positive influence on net return and thereby benefit-cost ratio (B:C ratio) over farmer's practice. The net return ranged from Rs.68,690/- to Rs.96,000/- per ha under demonstration as compared to Rs.53,600/- to Rs.79,917/- per ha in farmer's practice.

It was observed that the additional returns ranged from Rs.14,480/- to Rs.16,083/- per ha under demonstrations during these years.

The higher benefit-cost ratio was also recorded under Demo and the observed B:C ratio was 3.08, 2.38 and 2.48 during 2019-20, 2020-21and 2021-22, respectively as compared to 2.44, 1.98 and 2.11, respectively under farmers practice.

Higher gross returns (Rs.1,31,143/-), net returns (Rs. 82,310/-), and a B:C ratio (2.69) were recorded in demonstration plots compared to the farmer's practice. The variation in net return and benefit-cost ratio may be attributed to the variation in the price of inputs and produce. These findings are also supported by the findings of [17] and [2].

Looking at the success of the technology, the farmers of the nearby villages are showing interest in green manuring, especially the farmers cultivating rice. Using this technology the farmers could harvest good yield from their crop. Presently many farmers are approaching the beneficiary farmers and the KVK for seeds of Dhaincha. Thus, vertical as well as horizontal spread of the technology has been observed in the district.In this FLD cost of cultivation was reduced almost Rs. 5111/- per ha. Compared to farmer's practice this may be due to the less application of fertilizers and pesticides in Demo plots compared to farmers practice. This could be achieved due to the reduced application of one complex fertilizers bag and one urea bag and around 2 sprayings of pesticides. Because of this, it may reduce the cost of cultivation in demonstration plots. Not only it reduces cost of cultivation it also involved in improving soil properties like physical & chemical properties because by decomposing green manure crops can give organic matter to the soil so by this it will help in improving organic carbon content of soil also.

So by this intervention, the application of green manure preceding to rice can improves the soil properties and reduces the cost of cultivation without a reduction in yield also. Green manure amendments stimulate soil microbial growth, enzymatic activity, microbial biomass carbon, and nitrogen with subsequent mineralization of plant nutrients. Application of high-quality green manure such as legumes with low lignin and low C/N ratio could provide nutrients more efficiently by releasing nutrient quickly to plant. Sesbania ranks first among green manures in contributing biomass and nitrogen to the fields [5].

Table: 2Demonstration on sowing of green manure before rice from 2019-20 to 2021-22

S. No	Year	Mandal	Name of the village	No of locations	Area (inc.)
1	2019-20	Rudrur	Rudrur	03	1.2
		Bodhan	Hunsa	01	0.4
		Kotagiri	Suddulam	01	0.4
	2020-21	Rudrur	Lingampalli	01	0.4

2	2020-21	Kotagiri	Kollur	01	0.4
			Hungarga farm	02	0.8
			Raikur	01	0.4
			Gannaram	01	0.4
			Baswapur	02	0.8
			Eklaspur	01	0.4
		Bodhan	Minarpalli	01	0.4
3	2021-22	Kotagirir	Eklaspur	05	2.0
	Total			**20**	**8.0**

Table 3: Effect of green manuring on Initial and post-harvest soil organic carbon and available nitrogen content

Year	O.C (%)			Available N content (kg/ha)		
	Initial	After harvest	%Deviation	Initial	After Harvest	Deviation %
2019-20	0.366	0.372	1.64	169.6	170.8	0.71
2020-21	0.478	0.484	1.26	208.58	209.28	0.34
2021-22	0.434	0.442	1.84	223.2	224.8	0.72
Average	0.426	0.433	1.56	200.46	201.63	0.58

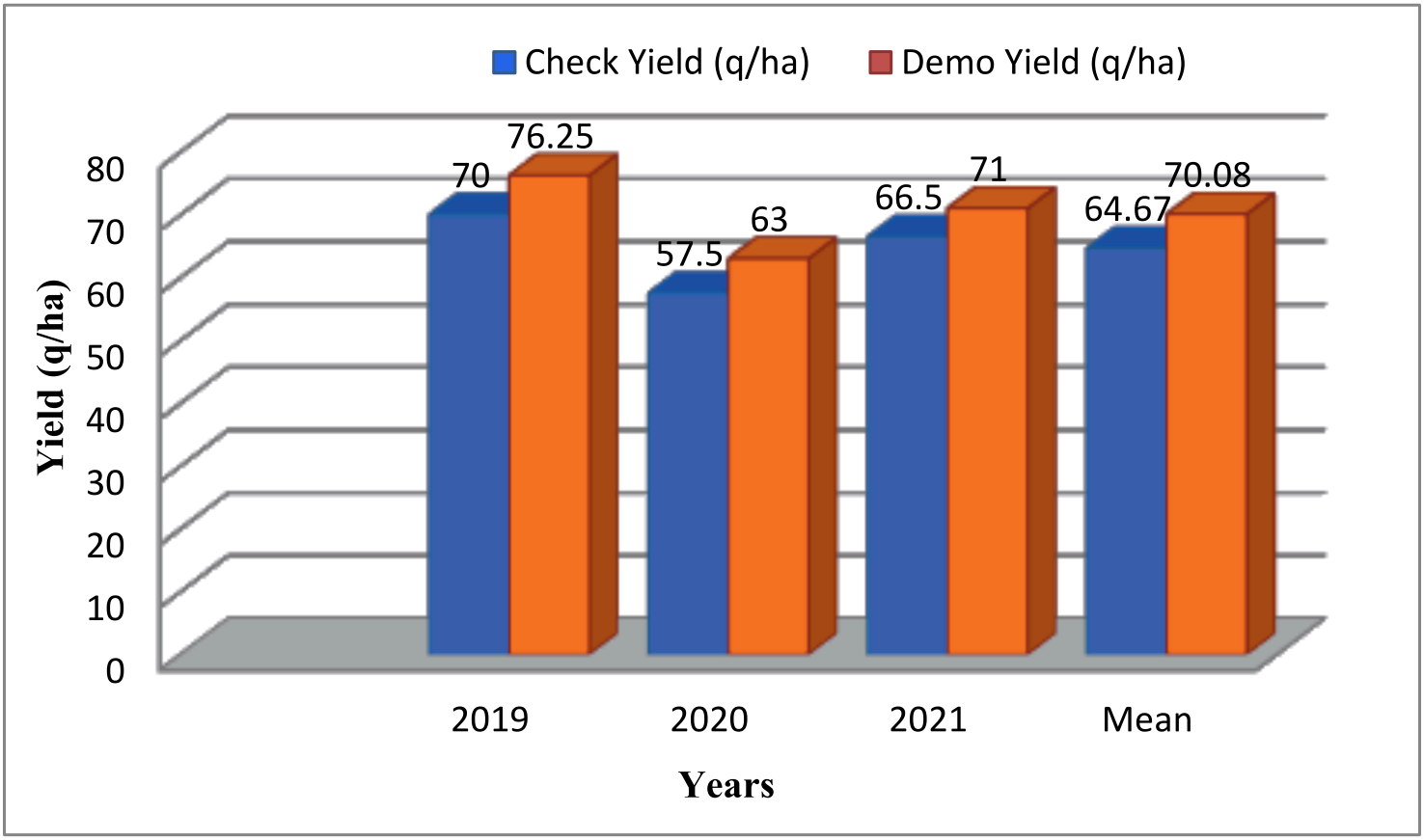

Fig.1 Yields of Rice Farmer practice &Greenmanuring (Dhaincha) before rice crop yields from 2019-20 To 2021-22

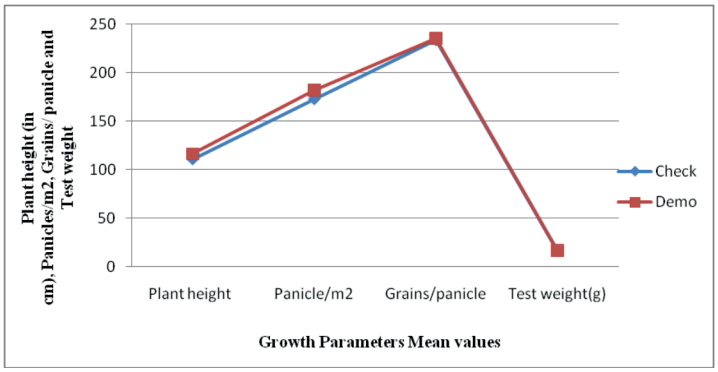

Fig.2Growth Parameters Mean values in farmer's practice and demonstration plots during 2019-20 To 2021-22

The results revealed that the net returns from the demonstrated plots were received more than the control plot. The average net return from the demonstration plot was recorded at Rs. 82,310Rs/ha as compared to the control plot i.e. Rs67,092 Rs/ha. The additional income of Rs. 15,218 Rs/ha was due to the technological interventions in demonstration plots. FLDs recorded a higher B: C ratio of 2.69 in comparison to farmers' practice (2.24). The higher returns obtained under demonstrations could be due to improved technology, timely operations of crop cultivation, non-monetary factors, and scientific monitoring. The results confirm the findings of front-line demonstrations on pulse crops by [24] and [12].

Table: 4 Influence of FLDs on seed yield and economic parameters of rice crop

Year	Average Yield (q/ha)		% increase over FP	Extension Gap (q. ha^{-1})	Cost of cultivation (Rs. ha^{-1})		Additional cost (Rs. ha^{-1}) in Demo over FP	Gross returns (Rs. ha^{-1})		Net returns (Rs. ha^{-1})		Additional return (Rs. ha^{-1}) IN Demo	Effective gain (Rs. ha^{-1})	B: C Ratio	
	(FP)	Demo			(FP)	Demo		(FP)	Demo	(FP)	Demo			(FP)	Demo
2019-20	70.00	76.25	8.93	6.25	46083	41250	-4833	126000	137250	79917	96000	16083	20916	2.44	3.08
2020-21	57.50	63.00	9.57	5.5	54500	49750	-4750	108100	118440	53600	68690	15090	19840	1.98	2.38
2021-22	66.50	71.00	6.77	4.5	61250	55500	-5750	129010	137740	67760	82240	14480	20230	2.11	2.48
Mean	64.67	70.08	8.38	5.42	53944	48833	-5111	121037	131143	67092	82310	15218	20329	2.24	2.69

Conclusion

The frontline line demonstrations (FLDs) conducted by KVK enhanced the average yield of rice vertically and ensured the rapid spread of recommended technologies of rice production horizontally by the implementation of various extension activities like training programmes, field day, etc.The frontline line demonstrations (FLDs)made a positive impact on the average yield of rice 8.38%.

Green manure- based systems may provide alternatives to current approaches to crop production; however, the use of Green manure may not be economically justified without the provision of multiple services such as nutrient supply, weed control and improvement of soil properties for sustainable crop production.

This can be seen as a positive indicator for formulating an objective-specific and extensive FLD program to train and educate farmers about improved rice production practices through 'working by doing' and 'doing by learning' for ensuring higher rice production in the region.

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