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Impact of green manuring preceding to rice crop on rice yield and cost of cultivation in Karimnagar district of Telangana state

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Abstract

Green manuring has emerged as an ecofriendly and sustainable agronomic practice that enhances soil fertility, improves crop productivity and reduces dependence on chemical inputs. This study was conducted to evaluate the impact of green manuring preceding to rice crop on rice yield and cost of cultivation in the Karimnagar district of Telangana State, a region characterized by intensive rice based cropping systems. In this context, Thirty Front line demonstrations were conducted by Krishi Vigyan Kendra, Jammikunta, Karimnagar district, Telangana state from 2019-20 to 2021-22, using green manure crops such as *Sesbania aculeata* (Daincha), *Crotalaria juncea* (Sunhemp) incorporated into the soil prior to transplanting rice. The treatments were compared against conventional rice cultivation without green manuring. Results showed a notable improvement in plant height (114.6 cm), number of tillers (17.6), panicle length (22.9 cm) and grain yield (6665 kg/ha) in green manured treatments, compared to the control plots, which recorded 103.9 cm, 14.9 tillers, 19.1 cm and 6121 kg/ha respectively. Moreover, cost-benefit analysis revealed reduced input costs, especially in fertilizer usage and higher net returns, showcasing the economic viability of this practice. The study underscores the potential of green manuring as a low cost, environmentally sound technique to enhance rice productivity and profitability in the Karimnagar district. The findings recommend wider adoption of green manuring as part of integrated nutrient management strategies for sustainable rice farming in Telangana.

Keywords: Rice, green manures, front line demonstrations, green manure treatment (Demo practice), control treatment (Farmer practice)

Introduction

Rice (*Oryza sativa* L.) is the principal staple food crop of Telangana, cultivated in an area of around 25 lakh hectares, with a total production of 135 lakh million tonnes and an average productivity of 33 quintals per hectare (Socio Economic Outlook 2024) ^[2]. It plays a vital role in ensuring food security and supporting the livelihoods of rural communities, especially in districts like Karimnagar, where rice based cropping systems are predominant, with cultivation spanning 1,10,514 hectares during the *Kharif* season and 96,822 hectares in the *Rabi* season (CDA, 2024-25) ^[1]. However, the sustainability of rice production in the region is increasingly challenged by declining soil fertility, over-reliance on chemical fertilizers, rising input costs and stagnating yields.

In this context, green manuring the practice of growing and incorporating fast growing leguminous crops into the soil before planting the main crop has gained renewed attention as a cost effective and ecofriendly strategy to enhance soil fertility, organic matter and nutrient cycling. Green manure crops such as *Sesbania aculeata* (Daincha) and *Crotalaria juncea* (Sunhemp) are known for their ability to fix atmospheric nitrogen, suppress weeds and improve soil physical properties, making them highly suitable for rice based cropping systems. Several studies have highlighted the positive impacts of green manuring on rice productivity and soil health. According to Sharma *et al.* (2019) ^[7], the incorporation of *Sesbania aculeata* before

rice transplanting increased grain yield by 12-15% while reducing the need for nitrogen fertilizers. Singh and Yadav (2020) ^[9] reported improved soil organic carbon and microbial activity in green manured treatments compared to control. Similarly, research conducted by Ramesh *et al.* (2018) ^[5] in Andhra Pradesh indicated that green manuring helped reduce cultivation costs by minimizing fertilizer inputs and enhancing nutrient use efficiency. These findings suggest that green manuring not only improves yield but also contributes to sustainable and climate resilient farming.

Despite such evidence, localized studies in Telangana, particularly in the Karimnagar district are limited. Given the region's dependence on rice and the challenges associated with rising costs and environmental degradation, it is important to evaluate the practical benefits of green manuring under local agro climatic conditions. Therefore, the present study was undertaken to assess the impact of green manuring preceding to rice crop on rice yield and cost of cultivation in Karimnagar district of Telangana State. The findings are expected to provide valuable insights for farmers, researchers and extension agencies to promote sustainable rice cultivation practices in the region.

Materials and Methods

Frontline demonstrations on green manuring preceding to rice crop were carried out at thirty different locations during the *Kharif* seasons from 2019-20 to 2021-22. These locations were in Saidapur, Ellanthakunta and Chigurumamidi mandals of Karimnagar district, Telangana. The demonstrations were done with the active help and participation of local farmers. Scientists from Krishi Vigyan Kendra, Jammikunta, guided the farmers through different extension activities. These included regular visits to the fields, awareness programs, training sessions and one on one communication to explain the benefits and methods of green manuring.

The soils in the study area ranged from sandy loam to black soils, with a slightly acidic reaction (pH 5.5 to 6.0). The fertility status showed low to medium organic carbon content, low to medium available nitrogen, medium to high available phosphorus and medium to high potassium levels, providing a conducive environment for the growth of green manure crops and subsequent rice cultivation.

Green manure in paddy fields

Seeds of the green manuring crop (Daincha & Sunhemp), were sown during the month of May using a seed rate of 30 kg per hectare. After growing for 5 to 6 weeks, the green manure crops were chopped into small pieces and incorporated into the soil using a tractor drawn rotavator. Following this, rice seedlings were transplanted into the field and all recommended crop management practices, from land preparation to harvesting were carried out at appropriate times.

Observations on various yield parameters of the rice crop were

recorded to assess the impact of green manuring. Additionally, an economic analysis was performed to evaluate the cost effectiveness of the practice. Soil samples were collected after rice harvest each year and analysed for organic carbon content and available nitrogen to study the changes in soil fertility over time.

Results and Discussion

Based on the demonstrations conducted during three consecutive *kharif* seasons 2019, 2020 and 2021, it was observed that the green manuring preceding rice crop improved the productivity and profitability of rice.

Effect on Growth and Development

At maturity, the green manuring treatment recorded the highest plant height (114.6 cm) and greater number of productive tillers per hill (17.6) compared to the control (no green manuring) treatment. This enhancement in growth parameters can be attributed to the increased availability of organic matter, nitrogen and other essential nutrients in the green manure incorporated plots.

Recent studies by Suresh *et al.* (2023) ^[11] and Meena *et al.* (2021) ^[3] have similarly reported that green manure incorporation significantly improves early vegetative vigour, promotes tiller formation and enhances overall plant architecture. These effects are largely driven by improved nutrient availability, especially ammoniacal nitrogen (NH₄⁺-N) and enhanced microbial activity, which create favourable soil conditions for root development and tiller initiation in rice.

Effect on yield attributes

From the data table 1 it shows that, the panicle length was highest (22.9 cm) in the green manure treatments, compared to the lowest (19.1 cm) observed in the control treatment. Similarly, the number of grains per panicle increased to 179 in the green manure plot, while the control recorded only 158 grains per panicle.

This improvement in panicle length may be attributed to the taller plant stature, increased number of productive tillers and greater dry matter accumulation in the green manure treatments. These findings align with the results of Ram Kawal Yadav *et al.* (2009) ^[12], Meena *et al.* (2021) ^[3] and Singh *et al.* (2022) ^[8] who reported that enhanced vegetative growth positively impacts panicle development.

Moreover, the higher number of grains per panicle in the demonstration plots could be linked to the sustained availability of nutrients during the reproductive phase, which supported active photosynthesis and improved assimilate translocation towards the developing grains. As highlighted by Suresh *et al.* (2023) ^[11], continuous nitrogen availability and improved soil health through green manuring significantly contribute to better grain filling and increased spikelet fertility.

Table 1: Details of Growth and Yield attributes of Rice as influenced by Green manuring

Year	Particulars	Plant height (Cm)	No.of Productive tillers/hill	Panicle length (cm)	No.of grains/panicle
2019	Farmer practice	102.3	15.6	19.2	162
	Demo practice	113.6	17.4	23.3	183
2020	Farmer practice	105.4	14.2	18.6	154
	Demo practice	114.8	18.6	21.7	181
2021	Farmer practice	105.2	15.1	19.5	159
	Demo practice	115.6	16.8	23.8	175
Mean	Farmer practice	103.9	14.9	19.1	158
	Demo practice	114.6	17.6	22.9	179

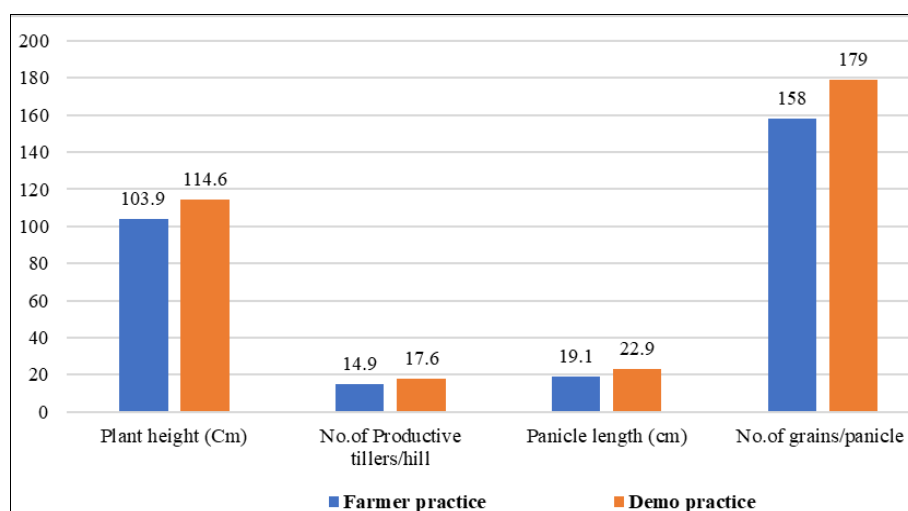


Fig 1: Comparative performances of yield attributes under green manure & control treatments

Effect on yield: From the yield data of three consecutive years presented in Table 2, it was observed that, green manure incorporated treatment recorded higher grain yield (6665 Kg/ha) than control plot (6121 Kg/ha). An 8.88% increase in grain yield was observed over the control, which might be due to higher number of panicles per unit area and number of grains per panicle. Rice is relatively leafy in its early growth stages and adequate supply of nutrients enhances its photosynthetic rate and

nutrient uptake, ultimately leading to higher grain yield (Zahir Shah *et al.* 2011) ^[14]. Similar yield improvements due to green manure incorporation have also been reported by Suresh *et al.* (2023) ^[11] and Yadav *et al.* (2020) ^[13], who found that green manuring significantly enhances nitrogen availability, tillering capacity and grain formation in rice under Indian agro ecological conditions.

Table 2: Details of yield and economics of Demo and farmer practice

Year	Particulars	Grain yield (Kg/ha)	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C
2019	Farmer practice	5860	44475	128920	84445	1.90
	Demo practice	6240	40725	137280	96555	2.37
2020	Farmer practice	6120	48375	134640	86265	1.78
	Demo practice	6780	44650	149160	104510	2.34
2021	Farmer practice	6384	51375	140448	89073	1.73
	Demo practice	6975	47250	153450	106200	2.25
Mean	Farmer practice	6121	48075	134662	86587	1.80
	Demo practice	6665	44208	146630	102422	2.32

Effect on economics:

The results of the economic evaluation clearly indicated that the demonstration plots consistently recorded higher gross and net returns over a span of three years compared to the control (farmer's practice) plots. The demonstration not only improved profitability but also had a positive impact on the benefit cost (B:C) ratio.

The net returns under the green manure treatments ranged from Rs. 96,555/- to 1,06,200/- per hectare, whereas the control plots yielded comparatively lower net returns, ranging between Rs. 84,445/- and 89,073/- per hectare. The average B:C ratio was higher in the green manure treatments (2.15) compared to the control treatment (1.82), indicating improved economic viability of green manuring practices over traditional methods.

The average additional income gained per hectare from the demonstrated plot was Rs.15,835/-, which may be attributed to an increase in grain yield and a reduction in the cost of cultivation, as also reported in similar studies highlighting the economic benefits of green manuring (Patra *et al.*, 2017; Singh *et al.*, 2019; Reddy & Padmaja, 2021) ^[4, 10, 6]. These studies have demonstrated that incorporating green manure improves soil fertility, enhances nutrient availability and reduces dependency on chemical fertilizers, thereby increasing profitability for farmers

The adoption of green manuring practices led to an average reduction in the cost of cultivation by Rs.3,867/- per hectare. This cost saving was primarily attributed to a reduction in urea application by approximately 2.5 bags per hectare and the avoidance of one or two pesticide sprays, owing to improved soil health and natural pest suppression. Similar findings have been reported by Patra *et al.* (2017) ^[4] and Singh *et al.* (2019) ^[10], who observed that green manuring not only reduces chemical input costs but also enhances ecological sustainability in rice based systems.

Changes in Soil Fertility Status:

Table 3: Effect of green manuring on soil organic carbon and available nitrogen content

Year	O.C (%)			Available N content (kg/ha)		
	Pre analysis	Post analysis	% Deviation	Pre analysis	Post analysis	% Deviation
2019-20	0.336	0.342	1.78	173.9	174.6	0.40
2020-21	0.359	0.364	1.39	191.5	192.6	0.57
2021-22	0.328	0.333	1.52	206.8	207.9	0.53
Average	0.341	0.346	1.46	190.73	191.7	0.50

The results of the study indicated that the incorporation of green manure crops, particularly *Daincha* (*Sesbania aculeata*), prior to rice cultivation significantly improved the physicochemical properties of the soil. Over a span of three consecutive years, there was a consistent increase in soil organic carbon (SOC) content after the harvest of rice (Table 3). On average, green manuring led to a 1.46% increase in SOC, which can be attributed to the accumulation of biomass through root residues and natural leaf shedding by the leguminous green manure crop. These organic inputs enhanced microbial activity, improved soil structure and contributed to better nutrient cycling, thereby supporting long term soil health.

In addition to enhancing organic carbon, green manuring also improved the soil's available nitrogen status. The initial available nitrogen levels were recorded as 173.9, 191.5, and 206.8 kg/ha during 2019-20, 2020-21 and 2021-22 respectively, with an average of 190.73 kg/ha. After the incorporation of *Daincha*, an average annual increase of 0.50% in available nitrogen was observed. This rise is likely due to biological nitrogen fixation and the decomposition of legume biomass, which enriched the nitrogen pool in the soil. The cumulative effect of these improvements suggests that the Frontline Demonstrations (FLDs) had a positive impact on maintaining and enhancing soil fertility.

These findings align with those of Patra *et al.* (2017)^[4], Singh *et al.* (2019)^[10], and Reddy & Padmaja (2021)^[6], who reported that green manuring in rice based cropping systems improves both soil organic carbon and nitrogen availability, while reducing dependency on chemical inputs. Furthermore, Suresh *et al.* (2023)^[11] documented similar enhancements in nutrient content and crop yield due to green manure incorporation in Telangana and Yadav *et al.* (2020)^[13] emphasized the long term benefits of organic inputs on nitrogen dynamics and sustainable rice productivity in Indian conditions.

Impact in the district

The implementation of FLDs on green manuring preceding to rice crop in Karimnagar district demonstrated substantial agronomic and economic benefits at the field level. On average, an 8.88% improvement in rice yield was observed in demonstration plots compared to traditional practices. Additionally, the incorporation of *Daincha*, *Sunhemp* significantly reduced input usage, with an average saving of 112.5 kg of urea per hectare and the elimination of one to two pesticide sprays, particularly insecticides due to enhanced natural pest resistance and improved plant health.

Encouraged by these results, the practice was scaled up to 11,652 hectares across the district through convergence with the Department of Agriculture. This expansion resulted in substantial resource conservation and financial savings. A total of 13,10,850 kgs of urea (approximately 1310.85 tons) were saved across 11,642 hectares, leading to a direct monetary saving of Rs.87,39,000/- in fertilizer costs alone. These outcomes underline the potential of green manuring as a climate resilient and cost effective intervention for sustainable rice production in Karimnagar and similar agro ecological regions.

Conclusion

The study clearly demonstrates that green manuring preceding to rice cultivation significantly improves both crop yield and economic returns in the Karimnagar district of Telangana. Incorporating green manure crops such as *Sesbania aculeata* and *Crotalaria juncea* led to improved plant growth, increased grain yield and reduced input costs particularly fertilizers and

pesticides. The practice proved to be both agronomically effective and economically viable.

Overall, the findings strongly support the wider adoption of green manuring as an ecofriendly, low cost and sustainable agronomic practice. It should be promoted as a vital component of integrated nutrient management strategies to ensure sustainable rice production in Telangana and similar agro ecological regions.

In this aspect government should focus and green manure seed should be made available to farmers before Kharif season will increase large scale adoption of green manuring.

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