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Impact of Improved Technologies on Rice Productivity and Profitability at Nalgonda District, Telangana

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ABSTRACT

The present study was conducted during *rabi* season of 2017–18 and 2018–19 (November–April) to assess the performance of rice variety KNM 118 (Kunaram sannalu) over existing farmers' popular variety MTU 1010 in fifty (50) number of farmers fields of Miryalaguda and Damaracherla mandals in Nalgonda District, Telangana, India under Tribal Sub-plan. Based on the collected data, per cent increase yield over the farmer's practice, economics such as gross returns, cost of cultivation, net returns, additional costs, effective gain, additional returns and incremental benefit-cost ratio were worked out. The technology gap, extension gap and technology index were calculated. The results revealed that the average grain yield was 7297.5 kg ha^{-1} in improved practice which was a 12.1% increase over the farmer's practice i.e. 6510.0 kg ha^{-1} during the study period. Mean of the extension gap, technology gap, and technology index were 787.5 kg ha^{-1}, 202.5 kg ha^{-1}, and 2.7%, respectively over the seasons. The average gross returns and net returns of ₹ 1,29,211.3 ha^{-1} and ₹ 76,812.8 ha^{-1}, respectively were higher in demonstration plots as compared to farmer's practices over the two seasons. The benefit-cost ratio recorded was 2.5 in improved practice, and 2.2 in farmer's practices. The average sustainability yield index and sustainability value index in improved practice were 0.94 and 0.88 and in the farmer's practice were 0.94 and 0.89 during the study period. The horizontal spread of the improved practice was increased from 107.5 ha to 1442.0 ha, which was 1222.8%.

KEYWORDS: Economics, frontline demonstrations, horizontal spread, rice, SYI, SVY, yield

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1. INTRODUCTION

The main aim of frontline demonstrations is to showcase the evaluation of improved newly released and notified varieties with improved crop production and protection technologies on farmers' fields under various agro-climatic conditions and farming situations in cluster approach (Narendrasingh et al., 2021, Singh et al., 2020). Cultivation of high yielding varieties in frontline demonstrations surely enhance crop productivity per unit area and reduce the adoption gap (Ranawat et al., 2011, Rai et al., 2016), replace old varieties (Shaik et al., 2018b), early arrival of produce in markets (Singh et al., 2013). Rice (*Oryza sativa* L.) is a staple food for more than half of the world's population and one of the most significant cereal crops in India (Joshi et al., 2018). Annually, India produces 118.87 mt of rice in an area of 43.66 mha with an average yield of 2722.0 kg ha^{-1}. During 2020–21, in Telangana rice was cultivated in an area of 2.31 mha comprising 5.14% of India's total rice-growing area. The annual production was 7.7 mt and the average productivity is 3327.0 kg ha^{-1} in the same period. In Nalgonda District, 2.8 lakh ha was under rice cultivation, yielding 9.58 lakh tonnes with an average productivity of 3440.0 kg ha^{-1} (Anonymous, 2021). India is self-sufficient in food grain production due to the rapid expansion of the rice cultivation into non-traditional areas, recommended dose of fertilizer application, cultivation of short duration high-yielding rice varieties, increased irrigation resources, adoption of improved and location-specific technologies (Campbell et al., 2016), development of infrastructure and increased minimum support price (Singh et al., 2017), development of high yielding rice varieties resistance to abiotic and biotic stresses through novel biotechnological tools (Shaik et al., 2018a).

The yield gap between potential yield and actual yield is more pronounced due to a number of various factors including farmers' limited knowledge of improved practices (Ravindra and Singh, 2019; Khan et al., 2021), lack of awareness on new high yielding cultivars (Najeeb et al., 2018), and continuous cultivation of a single variety that makes them more vulnerable to pests and diseases (Shrivastava et al., 2020, Ganeshkumar et al., 2020). Low rice productivity in farmer's fields is due to delayed sowings, lack of availability of high-quality seed, application of high dose of fertilizers, weed menace (Samant, 2017), non-adoption of improved high-yielding varieties, high incidence of pest and diseases (Zamir et al., 2017), and inadequate management practices (Sarvade et al., 2014; Subramani et al., 2014).

The public breed cultivar MTU 1010 (Cottondora sannalu) is a short duration (120–125 days), long slender, semi-dwarf variety resistant to blast, and tolerant to BPH but, lodging and shattering of grains is a problem along with this, other varieties viz., MTU 1153 and MTU 1156 are being majorly cultivated by farmers in the Nalgonda District. To meet the needs of farming community, Professor Jayashankar Telangana State Agricultural University (PJTSAU) in 2016 released a rice cultivar under the name of Kunaram Sannalu (KNM 118), a short duration variety which is outperformed than MTU 1010 in terms of yield, grain shattering, tolerant to lodging and disease resistance (Tamilazhaki et al., 2020). The cultivation of short duration varieties can produce two or three crops per year (Bagchi et al., 2012), have good grain quality (Islam et al., 2016), no lodging, escape pest damage, high net returns (Xu et al., 2018), overcome water shortage at tail end canal areas, reduction of greenhouse gas emissions (Hasan, 2014, Singh et al., 2020) and, drought escape (Ohno et al., 2018, Campbell et al., 2016). Hence, it's very important to assess performance of Kunaram Sannalu (KNM 118), a newly released variety in Nalgonda District, Telangana through cluster frontline demonstrations.

2. MATERIALS AND METHODS

The study was conducted through cluster frontline demonstrations on farmer's fields of Sitya thanda (V), Miryalaguda (M) and Ralavagu thanda (V), Damaracharla (M) during *rabi* season (November–April) of 2017–18 and 2018–19 in Nalgonda District of Southern Telangana Zone, India under Tribal Sub Plan. The KVK scientists conducted the baseline survey in the two villages and had taken feedback of the farmer's *via* pre-seasonal training programmes and field visits. The scientific staff explained the advantage of growing short duration new rice variety KNM 118 which is fine, long slender grain type having test weight of 25–26 g, less prone to grain shattering, less lodging, potential grain yield of 7.0–8.0 t ha^{-1}, tolerance to leaf and neck blast with good cooking quality (Tamilazhaki et al., 2020) along with improved package of crop production and protection technologies. The farmers were selected through group discussions, interaction meetings, awareness programmes and field visits. Finally, a list of interested farmers was prepared, visited selected farmer's fields and collected soil samples at 1 m soil depth, analyzed soil samples and studied the physico-chemical properties of black soils in the cluster villages (Table 1).

The demonstrations were laid out in an area of 0.4 ha and adjacent field was treated as farmers' practice. Total of 50 demonstrations were conducted in different farmer's fields with latest improved package of practices in rice during both the years of *rabi* 2017–18 and 2018–19 (November–April). Details on demonstrations and farmer's practice were presented in Table 2.

Rice nurseries were sown in the second fortnight of November and transplanted in the second fortnight of

December and harvestings were taken up during first week of April. The KVK scientists explained the farmer's about the latest improved package of practices and made them to adopt these in field demonstrations and traditional practices were adopted in farmers' practice. KVK staff were also organized extension programmes *viz.*, method demonstrations, farmer scientist interaction meetings, need-based training programmes, monitored incidence of pests and diseases through regular field visits, and conducted field days prior to the harvest involving more farmers to showcase the technologies for its horizontal spread. The literature on improved package of practices in rice was distributed to the farmers' of the cluster villages.

Table 1: Physico-chemical properties of soil samples in demonstration fields (0–30 cm depth)

Sl. No.	Soil particulars	
1.	pH	7.11–7.18
2.	EC (dS m^{-1})	0.31–0.39
3.	OC (%)	0.41–0.46
4.	Available N (kg ha^{-1})	193.4–224.2
5.	Available P (kg ha^{-1})	14.16–19.12
6.	Available K (kg ha^{-1})	128.1–131.4
7.	DTPA extractable Zn (mg kg^{-1})	0.44–0.47
8.	DTPA extractable Fe (mg kg^{-1})	4.12–4.16

Data on grain yield and economics were collected from all 50 farmers of the two cluster villages during *rabi* 2017–18 and 2018–19 under frontline demonstrations and farmer's practice through crop cutting experiments and analyzed as per standard statistical procedures. Based on the collected data, per cent increase yield over the farmer's practice, economics such as gross returns, cost of cultivation, net

Table 2: Details of technologies under improved practice and farmers' practice followed in the cluster front line demonstration of rice during *rabi* 2017–18 and 2018–19 at Nalgonda District, Telangana

Sl. No.	Particulars	Improved practice	Farmers' practice	Gap
1.	Seed rate	62.5 kg ha^{-1}	75.0 kg ha^{-1}	Partial gap
2.	Variety	KNM 118	MTU 1010	Partial gap
3.	Seed treatment	Carbendazim @ 1 g l^{-1} of water	No seed treatment	Full gap
4.	Nursery management	1. Application of carbofuran granules @ 200 g $cent^{-1}$ nursery. 2. Spraying of $ZnSO_4$ @ 2 g l^{-1}	1. Application of carbofuran granules @ 1 kg $cent^{-1}$ nursery. 2. No Spraying of $ZnSO_4$ @ 2 g l^{-1}	Partial gap
5.	Fertilizers	N:P:K-120:60:60 ha^{-1} and based on soil test results	Injudicious use of fertilizer	Partial gap
6.	Herbicides	Application of pre-emergence herbicide -Pretilachlor @ 1 l ha^{-1} after 48 h of transplanting Spraying of post emergence herbicide-Penoxsulam 2.5% @ 1 l ha^{-1} after 25 DAT	Application of pre-emergence herbicide -Pretilachlor @ 1 l ha^{-1} after 48 h of transplanting Second one manual weeding at the time of 30 DAT	Partial gap
7.	Cultural practice	a) Formation of alleyways 20 cm of every 2 m row at the time of transplanting b) Clipping off leaf tips of rice seedling before transplanting	No	Full gap
8.	Pheromone traps	Installation of pheromone traps @ 10 ha^{-1}	No	Full gap
9.	Bio-control agents	Release of Trichogramma japanicum @ 125000 ha^{-1} with five releases from 25 DAT to harvesting	No	Full gap
10.	Plant protection measures	a) Application of carbofuran 3G @ 25 kg ha^{-1} at 25 DAT b) Spraying of cartap hydrochloride 50 SP @ 2 g l^{-1} at vegetative stage c) Spraying of chlorantraniliprole 18.5 SC @ 0.3 ml l^{-1} at panicle initiation stage	a) Application of non-recommended granules @ 25 kg ha^{-1} b) Spraying of synthetic pyrethroids like Lambda cyhalothrin @ 2 ml l^{-1} at vegetative stage c) Spraying of Bifenthrin @ 2 ml l^{-1} at panicle initiation stage	Partial gap

returns, additional costs, effective gain, additional returns and incremental benefit-cost ratio were worked out. The technology gap, extension gap and technology index were calculated by the formulae as per Samui et al. (2000).

Percent increase over the farmer's practice (%)= Improved practice yield (kg ha^{-1})-Farmer's practice yield (kg ha^{-1})/ Farmer's practice yield (kg ha^{-1})×100 ………………(1)

Technology gap (kg ha^{-1})=Potential yield (kg ha^{-1})-Improved practice yield (kg ha^{-1}) …………(2)

Extension gap (kg ha^{-1})=Improved practice yield (kg ha^{-1})-Farmer's practice yield (kg ha^{-1}) …………..(3)

Technology index (%)=Potential yield (kg ha^{-1})-Improved practice yield (kg ha^{-1})/(Potential yield (kg ha^{-1})×100 …(4)

Additional returns (₹ ha^{-1})=Improved practice net returns (₹ ha^{-1})-Farmer's practice net returns (₹ ha^{-1})……………..(5)

Additional Cost (₹ ha^{-1})=Improved practice cost (₹ ha^{-1})-Farmer's practice net cost (₹ ha^{-1}) …………….(6)

Effective gain (₹ ha^{-1})=Additional net returns (₹ ha^{-1})-Additional Cost (₹ ha^{-1}) ……………..(7)

Incremental benefit-cost ratio=(Additional net returns (₹ ha^{-1})/(Additional cost (₹ ha^{-1}) ....(8)

Sustainability yield index and sustainability value index were calculated through the following formulae.

Sustainable yield index/Sustainable value index (SYI)=$(y-\sigma)/y_{max}$ ……………………..(9)

Where, y-Mean yield of a demonstration/mean net return over the year,

σ-Standard deviation (SD)

Ymax-observed maximum yield/maximum net return of a plot over the year.

Horizontal spread of area change (%)=(Area after demonstration (ha)-Area before demonstration (ha)/(Area before demonstration (ha)…………….(10)

3. RESULTS AND DISCUSSION

3.1. Yield

During *rabi* 2017–18 and 2018–19, 50 frontline demonstrations were conducted in about 20 ha area on farmers' fields in the villages of Sityathanda, Miryalaguda (M), and Ralavaguthanda, Damaracharla (M) in Nalgonda district, Telangana. Improved practice comprised of introduction of a new rice variety and improved package of practices and farmer's practice were conducted and the results are presented in Table 3. During *rabi* 2017–18 and 2018–19 the average rice grain yields in improved practice were significantly high i.e., 7525.0 kg ha^{-1} and 7070.0 kg ha^{-1}, respectively with per cent increase of 13.2% and 11.0% as compared to farmer's practice (6650.0 kg ha^{-1} and 6370.0 kg ha^{-1}, respectively). Over the years also, the mean rice grain yield was significantly high in improved practice (7297.5 kg ha^{-1}) than in farmer's practice (6510.0 kg ha^{-1}) with 12.1% yield superiority.

Table 3: Average yield of improved practice and farmers' practice during *rabi* 2017–18 and 2018–19 in Nalgonda District, Telangana

Year	No. of demos	Variety	Yield (kg ha^{-1})		Percent increase yield over the control
			IP	FP	
2017–18	25	KNM 118	7525.0#	6650.0#	13.2
2018–19	25	KNM 118	7070.0#	6370.0#	11.0
Total	50		7297.5	6510.0	12.1
t-value			18.48		
p- value			<0.00001*		

IP: Improved practices; FP: Farmer's practices; #:Average grain yield of 25 farmer's; *Significant at p=0.05

These results clearly indicated that the higher yields were obtained in demonstrations due to adoption of the improved new rice variety Kunaram sannalu (KNM 118) along with improved modern production and protection measures, such as seed treatment to protect against seed borne diseases, application of carbofuran granules @ 200 g $cent^{-1}$ area at nursery stage, spraying of zinc sulphate @ 2.0 g l^{-1} for cold management in *rabi* season, clipping off leaf tips of rice seedlings before transplanting, formation of alleyways, application of soil test based recommended dosage of fertilizers, pre-emergence herbicidal application, installation of pheromone traps, release of bio-control agents, application of carbofuran granules, spraying of cartap hydrochloride and chlorantraniliprole at the vegetative and panicle initiation stages to control stem borer. The released rice variety KNM 118 produced higher yields in demonstrations by practicing recommended package of practices for two consecutive years.

Yields were low in farmer's practice due to poor management practices, use of age old varieties, non-adoption of the recommended package of practices, and indiscriminate use of pesticides. The main differences observed between improved and farmer's practices were seed treatment, time of sowing, application of recommended dose of fertilizers, and need-based plant protection measures. These results showed that higher yields were in improved practice as compared to farmer's practice under the same environmental conditions. These findings were in concurrent with that of Mitra et al. (2014), Verma et al. (2016), Chaudhari et al. (2017), Samant (2017), Ganeshkumar et al. (2020), Khan et al. (2021) and Jayalakshami et al. (2021) who reported that frontline demonstrations with improved practices led to higher yields in rice.

3.2. *Technology gap (kg ha^{-1})*

Technology gap differences between the potential yields and demonstration yields were -25.0 kg ha^{-1} and 430.0 kg ha^{-1} in 2017–18 and 2018–19, respectively and the average technology gap was 202.5 kg ha^{-1} (Table 4). The technology gap was narrowed in 2017–18 due to the adoption of the improved new rice variety KNM 118 with latest agro-technologies under supervision of KVK scientists that resulted in higher yields in demonstration plots. The technological gap varied in the two demonstrated years due to climatic conditions, soil fertility, and location-specific recommendations. Similar findings were observed by Samant et al. (2017), Mandavkar et al. (2012), Vijendrakumar et al. (2015) in rice and emphasized the need for awareness programmes through various extension methods. Shivran et al., 2020 in chickpea reported that the yield enhancement in demonstrations is due to adoption newly released high yielding varieties with improved technologies.

Table 4: Technology gap, extension gap, technology index during *rabi* 2017–18 and 2018–19 in Nalgonda district, Telangana

Year	Technology gap (kg ha^{-1})	Extension gap (kg ha^{-1})	Technology index (%)
2017–18	-25.0#	875.0#	-0.3#
2018–19	430.0#	700.0#	5.7#
Total	202.5	787.5	2.7

#: Average grain yield of 25 farmers

3.3. *Extension gap (kg ha^{-1})*

Differences in extension gap between demonstration yield and farmer yield were 875.0 kg ha^{-1} and 700.0 kg ha^{-1} during 2017–18 and 2018–19, respectively and over the years, average extension gap was 787.5 kg ha^{-1} (Table 4). Adoption of latest improved recommended package of practices in demonstration plots resulted in higher yields than in farmer's practice. The Extension methods, such as frontline demonstrations, group discussions, farmer-scientist interaction meetings, training programmes, method demonstrations, WhatsApp groups, AKPS, phone calls, and field days are to be encouraged to impart knowledge to the farmer's on latest agro technologies to reduce the extension gap. Mubark and Shakoor (2019) reported that the average extension gap was 6.32 q ha^{-1} in improved practice. The extension gap was higher in improved practice and was in agreement with Mitra et al. (2014); Verma et al. (2016) in rice; Shivran et al. (2020) in chickpea.

3.4. *Technology index (%)*

Technology index is the difference between the potential yield and improved practice yield of a variety in comparison to the potential yield. Mean technology index was 2.7% and technology indices were -0.3% and 5.7% during 2017–18 and 2018–19, respectively (Table 4). Lower the value of the technology index, greater the feasibility of the variety and technology among farmers and low technology index value in 2017–18 reflected the feasibility of demonstrated technologies in farmer's fields. The variation in the technology index during the two years of experimentation was due to uneven rainfall and variations in climatic conditions. These findings were in concurrent with that of Verma et al. (2016), Mitra et al. (2014), Chaudhari et al. (2017), Samant and Susanta (2020) and reported that if technology index was low it need to educate the farmers' in rapid adoption of improved technologies. The technology index ranged 5.6 to 14.8% and observed that this indicates the technology is feasible for adoption. (Singh et al., 2020).

3.5. *Economic returns*

Based on input and output prices of commodities, estimated gross returns, net returns, cost of cultivation, additional net returns, additional cost, effective gain, and incremental benefit-cost ratio were worked out under the cluster frontline demonstrations (Table 5). The cultivation of rice under improved practice gave higher gross returns of ₹ 1,34,697.5 ha^{-1} and ₹ 1,23,725.0 ha^{-1} in 2017–18 and 2018–19, respectively than the farmer's practice of ₹ 1,19,035.0 ha^{-1} and ₹ 1,11,475.0 ha^{-1}, respectively with an average of higher gross returns of ₹ 1,29,211.3 ha^{-1} in improved practice against the farmer's practice ₹ 1,15,255.0 ha^{-1}. In the improved practice, higher net returns of ₹ 79,275.5 ha^{-1} was obtained against farmers' practice of ₹ 65,305.0 ha^{-1}during 2017–18 and in 2018–19 net returns were ₹ 74,350.0 ha^{-1} and ₹ 59,725.5 ha^{-1} in improved and farmers' practices, respectively. On the average, net return in demonstrations was ₹ 76,812.8 ha^{-1} as compared to farmer's practice of ₹ 62,515.3 ha^{-1}. The benefit-cost ratios in improved practice were 2.4 and 2.5 during 2017–18 and 2018–19, respectively while B:C ratio was 2.2 in both the years in the farmers' practice. An average benefit-cost ratio of 2.5 was found in demonstrations compared to 2.2 ratio of farmer's practice. In improved practice, ₹ 55,422.0 ha^{-1} was spent towards cost of cultivation during 2017–18 while it was ₹ 49,375.0 ha^{-1} during 2018–19. An amount of ₹ 53,730.0 ha^{-1} and ₹ 51,750.0 ha^{-1} were incurred on cost of cultivation in farmers' practice during 2017–18 and 2018–19, respectively. Average cost of cultivation was ₹ 52,398.5 ha^{-1} in the improved practice over farmer's practice of ₹ 52,739.8 ha^{-1}. In the improved practice, ₹ -341.3 ha^{-1} has been reduced against farmer's practice towards cultivation costs and additional net return of ₹ 13,110.3 ha^{-1} was obtained over the farmer's practice during the trial period. Mean effective gain was ₹ 13,451.5 ha^{-1} in the improved practice against farmers'

Table 5: Effect of improved technology and farmer's practice demonstrations on economics of rice during *rabi* 2017–18 and 2018–19 at Nalgonda district, Telangana

Particulars	2017–18		2018–19		Mean	
	IP	FP	IP	FP	IP	FP
Gross returns (₹ ha^{-1})	134697.5#	119035.0#	123725.0#	111475.0#	129211.3	115255.0
Cost of cultivation (₹ ha^{-1})	55422.0#	53730.0#	49375.0#	51749.5#	52398.5	52739.8
Net returns (₹ ha^{-1})	79275.5#	65305.0#	74350.0#	59725.5#	76812.8	62515.3
B: C ratio	2.4#	2.2#	2.5#	2.2#	2.5	2.2
Additional net returns (₹ ha^{-1})	-0.3#		5.7#		2.7	
Additional cost (₹ ha^{-1})	13970.5#		12250.0#		13110.3	
Effective gain (₹ ha^{-1})	12278.5#		14624.5#		13451.5	
Incremental benefit- cost ratio	8.3#		-5.2#		1.5	

IP: Improved practices; FP: Farmer's practices; Sale of paddy seed MSP: ₹ 15.90 kg in 2017–18 (1US$=₹ 65.09 INR); Sale of paddy seed MSP = ₹ 17.70 kg in 2018–19 (1US$=₹ 68.41 INR); #: Average grain yield of 25 farmers.

practice and average incremental benefit-cost ratio was 1.5. The economic differences between improved practice and farmer's practice might be due to the adoption of recommended practices and the cultivation of high-yielding, short-duration rice varieties in demonstrations that resulted in more economic returns in improved practice. These results coincided with Mitra et al. (2014) and Verma et al. (2016) in rice and reported maximum net returns with a high benefit-cost ratio in improved practice. Vijendrakumar et al. (2015) in rice also obtained maximum gross returns, net returns and benefit-cost ratio in FLDs with improved technologies. Higher gross returns, net returns and benefit-cost ratio were noticed in demonstrations (Shivran et al., 2020) in chickpea.

3.6. *Sustainability yield index/sustainability value index*

A quantitative measure for assessing an agricultural practice's long-term viability is sustainability. The lower standard deviation and coefficient of variation (CV) values suggested high yield sustainability and vice-versa. Sustainability index value ranged between zero to one and is calculated based on the yield recorded by different farmers over the years.

Sustainability yield index in improved practice were 0.93 and 0.94 over the farmer's practice 0.95 and 0.94 during 2017–18 and 2018–19, respectively with the mean of 0.94 in both the practices. In 2017–18, the sustainability value index was lower in improved practice (0.86) as compared to farmer's practice (0.88), whereas in 2018–19, it was higher in improved practice (0.91) against the farmer's practice (0.90) and the average was 0.88 in improved practice and 0.89 in farmer's practice (Table 6). The sustainability yield index and sustainability value indexes fluctuate due to more variations in farmer-to-farmer yields, returns and slight variations in demonstrations of improved technology. These findings clearly indicated that improved technology was more sustainable and ecofriendly than traditional farming. Reager et al. (2022), and Shankar et al. (2022) in groundnut noticed that sustainability yield index and sustainability value index were higher in improved practices. The maximum values of sustainability yield index and sustainability value index were found in improved technology on mustrad (Narolia et al., 2013).

3.7. *Impact of FLDs on horizontal spread of area under new rice variety KNM 118*

Impact of frontline demonstrations (FLDs) in the horizontal spread of new rice variety KNM 118 is shown in Table 7. The FLDs conducted on rice variety KNM 118 increased the area under improved rice varieties in the Nalgonda district. Through frontline demonstrations, area under improved rice variety KNM 118 was expanded from 107.5 ha in the first year (2016–17) to 1240.0 ha in 2017–18, and to 1442.0 ha in 2018–19. Due to excellent agronomical characteristics i.e. high yielding (7–8 t ha^{-1}), fine grain, short duration (120–125 days), non-grain shattering, non-lodging, tolerance to leaf blast and neck blast, good cooking quality, and good marketing price in public and private agencies, the area under cultivation of the rice variety Kunaram sannalu (KNM 118) has greatly increased. This variety is suitable for *kharif*, late *kharif*, and *rabi* seasons in Telangana and is being quickly spread through the efforts of Krishi Vigyan Kendra, Agricultural Research Station, Kampasagar, and Telangana State Seed Development Corporation, Nandhiphad, and the farmer's participatory approach in the district. The subsequent farmer's coverage and the expansion of the area led to the wider dissemination of the improved rice variety KNM 118 with the latest agro-technologies in the district. The efforts of KVK scientists through field visits, on-farm

Table 6: Effect of production practices on grain yield, net return, SYI and SVI of rice during *rabi* 2017–18 and 2018–19 in Nalgonda District, Telangana

Parameters	2017–18		2018–19		Mean	
	IP	FP	IP	FP	IP	FP
Grain yield (kg ha^{-1}) Max	7715.5	6807.0	7228.0	6528.0	7471.8	6667.5
Grain yield (kg ha^{-1}) Min	7262.5	6533.0	6825.0	6213.0	7043.8	6373.0
Grain yield Average	7525.0	6650.0	7068.0	6368.0	7297.0	6509.0
SD	320.3	193.7	285.0	222.7	302.6	208.2
CV (%)	1.6	1.0	1.46	1.36	3.51	2.49
Net returns (₹ ha^{-1}) Max	83763.8	69164.5	76544.0	62119.0	80153.9	65641.8
Net returns (₹ ha^{-1}) Min	73248.8	62968.7	70313.0	56719.0	71780.9	59843.9
Net returns average	79275.5	65305.0	74322.0	59676.0	76798.8	62490.5
SD	7435.2	4381.1	4406.0	3818.4	5920.6	4099.7
CV (%)	3.19	2.2	2.15	2.26	4.25	5.06
SYI	0.93	0.95	0.94	0.94	0.94	0.94
SVI	0.86	0.88	0.91	0.90	0.88	0.89

IP: Improved practices; FP: Farmer's practices; SD: Standard deviation; CV: Coefficient of variation; SYI: Sustainability yield index; SVI: Sustainability value index

Table 7: Extent of adoption of recommended technologies of rice variety KNM 118 before and after FLD during *rabi* 2017–18 and 2018–19

Sl. No.	Year	Variety	Before demonstration (Area ha^{-1})	After demonstration (Area ha^{-1})	Change in Area (ha)	Impact change (%)
1.	2017–18	KNM 118	107.5	1240.0	1132.5	1053.5
2.	2018–19		1240.0	1422.0	1314.5	1222.8

demonstrations, and farmer-scientist interaction meetings ensured the involvement of the farmers in spreading the improved technology. The frontline demonstrations had a big impact on the horizontal spread of the improved technology (1222.8%) and the successful implementation of improved technology is through a variety of extension activities like FLDs in the farmers' field. Therefore, the FLDs have a positive impact on the farming community in the district in replacing the old varieties. Similar results were reported by Sandeep et al. (2018) in groundnut, Amrish et al. (2017) and Najeeb et al. (2018) in rice and Satwinderjit et al. (2021) in gobhisarson and found FLDs were helped to increase the area under improved varieties in demonstrated villages.

4. CONCLUSION

The frontline demonstrations conducted gave higher yields, higher gross returns, net returns, high benefit-cost ratio, effective gain and incremental benefit-cost ratio over the existing farmer's practice. The awareness created among farmers about the technology was given good results which attracted the other farmers to practice hence the spread was remarkably high. Therefore, the FLD with the above interventions had proven to be effective under the prevailing situations in Nalgonda district.

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