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Yield gap analysis and economic viability of sorghum front line demonstration in Narmada district

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Abstract
Background: Among the cereals, sorghum is an important crop. Studies conducted in different areas show that stress and environmental damage are not the only factors causing decreasing crop yields and income. Uniform plant population deficiencies, major and minor nutritional deficiencies, high input costs, inadequate diffusion of new technologies, a lack of technical guidance and technology gaps all contribute significantly. The yield gap analysis and economic viability of the various components of sorghum farming have not been fully investigated yet. The primary goal of this project, which was carried out by IIMR Hyderabad under the AICRP program at the Main Sorghum Research Station, NAU, Athwa, Surat, was to boost production and productivity through Frontline demonstrations (FLDs) using the latest technologies.
Methods: The objective of the front-line demonstrations was to increase sorghum production. The two villages of fifty Frontline demonstrations on sorghum (CSV-55 and GJ-44) varieties were set up on 20 hectares in farmer's fields in Gujarat's Narmada district's Nana Pipariya and Boriya. Sorghum (CSV-55 and GJ-44) variety seed and NOVEL (Organic Liquid Nutrients) are the inputs that are scattered. Both in-person interviews and demonstrations of the latest sorghum technology were used to collect the data. Farmers' practices and the production parameters of both demonstrations were noted, and the percent yield enhancement, technology gap, extension gap, and technology index were examined.
Result: The average grain yield of demonstration plots was 2141 kg ha^{-1} over the local check 1824 kg ha^{-1} and fodder yield 6265 kg ha^{-1} over the local check 5615 kg ha^{-1}, respectively. There is an increase in grain yield by 17.67% and fodder yield by 16%. FLD could be a good option for enhancing farmers' income.

Keywords: Front line demonstration (FLD), technology gap, extension gap, CSV-55, GJ-44 and technology index

Introduction

Sorghum (*Sorghum bicolor* L.) is the third most produced cereal crop in India, after rice and wheat, and the fifth largest growing cereal crop in the world. It is grown by resource poor, small, and marginal farmers in the country's semi-arid regions. Sorghum is an essential crop in both the *kharif* and *rabi* seasons, providing not only food but also fodder for animal feed and fuel. Farmers' usage on local cultivars, lack of awareness of new technologies, and low MSP have all contributed to a drop in sorghum crop area in *kharif* over *rabi* in recent decades.

Every year, IIMR Hyderabad, under the AICRP program, allocates front line demonstrations to raise awareness among rural farmers and improve their standard of living. Under this project for the year 2025-26, the Main Sorghum Research Station, NAU, Athwa, Surat, selected the Nana Pipariya and Boriya villages of the Garudeshwar block of the Narmada district of Gujarat state and distributed improved variety seeds, packages of practices and conducted different activities such as farmers' rallies, Kisan melas, demonstrations and different scientist guidelines for farmers in the aspect of improving sorghum production and the socio-economic condition of farmers.

The frontline demonstration is one of the most important and powerful tools of extension because, farmers are generally motivated by the belief that 'Learning by doing and Seeing is believing. The main aim of FLD is to demonstrate recently released production technologies related to agriculture and its package and practices in the farmers field under different agro-climatic regions and farming situations (Meena, 2011) [14]. Frontline demonstration programme was effective in changing attitude, skill and knowledge of improved practices of sorghum including adoption this also improved the relationship between farmers and scientists and built confidence between them. Kirar *et al.* (2004) [11] reported that on partial and full adoption 17.50 and 7.50 per cent farmers increased in adopter condition over non adopter condition respectively. Verma (2013) [24] shows the distribution of beneficiaries according to their change of area after conducting the FLDs on their field. Unfortunately, use of local varieties and poor nutrient management results in very low yield.

Methodology

The study was conducted in the farmer's fields of Nana Pipariya and Boriya Villages in the Garudeshwar block of the Narmada district in *kharif* 2025 by the Main Sorghum Research Station, NAU, Athwa, Surat. A total of 50 FLDs were carried out in a 20 ha area in various places (25 FLDs in Nana Pipariya and 25 FLDs in Boriya Village). The difference between the demonstration package and existing farmer's practices mentioned in Table-1 and details of no of FLD in Table-2. Scientists from the Main Sorghum Research Station at NAU, Athwa, Surat, supervised every demonstration.

In *Kharif* 50 FLD (20 ha) demonstration plots, use of quality seed of improved varieties (CSV-55 and GJ-44), line sowing, seed treatment and timely weed control, as well as recommended dose of fertilizer (80 kg nitrogen+ 40 kg phosphorus) were emphasized. In case of farmer's practices, existing practices used by farmers were followed.

Before conducting the demonstration, training to the framers of respective villages was imparted with respect to envisaged technology interventions, site selection, farmer's selection, lay out of demonstration, and farmer's participation etc. Visits of scientists and the extension functionaries were organized at demonstration plots to disseminate the message at large scale. After collecting data on sorghum crop production from both FLD and control plots, yield attributes, seed yield, cultivation costs, net returns, and the benefit cost ratio were calculated. Statistical methods like frequency and percentage were used to tabulate and analyse the acquired data. The formulas proposed by Samui *et al.* (2000) [18], Kadian *et al.* (2004) [8] and Sagar and Chandra (2004) [17] were taken into consideration in order to evaluate the extension gap, technology gap, and technology index. The different parameters were calculated using the formula given below:

Technology gap = Pi (Potential yield) - Di (Demonstration yield)

Extension gap = Di (Demonstration yield) - Fi (Farmers yield)

$$\textbf{Technology index} = \frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential yield}} \times 100$$

Additional return = Demonstration return - farmer's practice return

$$\textbf{Percent increase yield} = \frac{\text{Demonstration yield} - \text{Farmers yield}}{\text{Farmers yield}} \times 100$$

Net returns = Total (Gross) Returns - Total Cost of Production

Incremental B: C Ratio = Additional Return / Additional Cost

The farmer's knowledge of enhanced fodder sorghum production procedures before and after the frontline demonstration was measured and compared using the student's test. The information on knowledge was recorded on a scale of full knowledge, significant knowledge, knowledge, least knowledge, and not knowledge, with score values of 5, 4, 3, 2, and 1. Furthermore, respondent farmers' satisfaction with extension services provided was assessed across a variety of dimensions, including farmer training, input supply, field problem solving and advisory services, scientific fairness, variety performance, and overall impact of front-line demonstrations. The Client Satisfaction Index was calculated using the method provided by Kumaran and Vijayaragavan (2005) [13], with some modifications. Farmers' satisfaction was measured using a five-point scale: strongly agree, agree, uncertain, disagree, and strongly disagree, with scores of 5, 4, 3, 2, and 1, respectively. All respondents were interviewed individually using a pre-tested and well-structured interview schedule. The satisfaction index was derived using the formula shown below.

$$\textbf{Client Satisfaction Index (CSI)} = \frac{\text{Individual obtained score}}{\text{Maximum score possible}} \times 100$$

The acquired data was tabulated and statistically analysed to interpret the results, as per Snedecor and Cochran (1994) [21].

Selection of the farmers: Farmers from the different categories including SC and ST, who are interested, cooperative and responsive, were selected.

Field layout: The field layout should be included farmer's practice. The component demonstration and total package demonstration need to be conducted separately. The field for FLD should be minimum of 0.4 ha.

Technology dissemination: Executed various extension activities such as farmers' day, field days, and field visits, elucidating the advantages of the shown technology compared to their existing practices, engaging the maximum number of farmers from the village and neighboring regions.

Results and Discussion

The grain and fodder yield and gap analysis of sorghum in demonstrated field's and farmer's practice is presented in table 3&4. Data revealed that average grain yield of demonstrated field's was higher from farmer's practice in *kharif* 2025. The results revealed that average grain yield and fodder yield of sorghum under frontline demonstrations were 2141 & 6265 Kg ha^{-1} respectively as compared to 1824 & 5615 Kg ha^{-1} respectively in traditional farmer practices plots. Average grain and fodder yield increase of 17.67% & 16% respectively. The above finding was in accordance with Singh *et al*., (2018). The average of technology gap, extension gap and technology index for grain & fodder were found to be 541.62 & 7764 Kg ha^{-1}, 319.79 & 883.50 Kg ha^{-1} and 20.56% & 15.80% respectively. (Table 3 &4). The similar results of yield enhancement crop production through frontline demonstrations have been documented by Singh *et al.* (2011) [20], Khadda *et al.* (2015) [10], Singh and Sharma (2016) [19], Govardhan Rao and Venkata Ramana (2017) [5], Khadda *et al.* (2018) [9], Singh *et al.* (2020), Bhutada *et al.* (2020a) [1] and Bhutada *et al.* (2020b) [2]. FLD increases farmers' economies in addition to increasing the yield of grains. The findings showed that the front-line demonstration had a positive effect on the farming community because the innovative agricultural technology used in the FLD plots inspired them.

This emphasized the need to educate the farmers through various extension means for the adoption of scientific practices in

cultivation of all the cereal crops and pulses crops (A. P. Thakur and Shurya Bhushan, 2016) [22]. This Extension gap should be assigned to adoption of improved dissemination process in recommended practices which outcome in higher grain yield than the farmer's practice. Similar yield enhancement in different crops in front line demonstration has amply been documented by Haque (2000) [6], Mishra *et al.* (2009) [16] and Kumar (2010) [12]. Yield of the front line demonstration trials and potential yield of the crop was compared to estimate the yield gaps which were further categorized into technology and extension gaps (Hiremath, S. M. and Nagaraju M. V., 2009) [7].
According to Thakur and Shurya Bhushan (2016) [22], the extension gap, which varied on average from 200 kg ha^{-1} to 900 kg ha^{-1} over the time, highlighted the necessity of educating farmers via various ways for adoption of improved agricultural techniques in order to reverse this trend of significant extension gap. In this regard, FLD is contributing significantly to the popularisation of enhanced diversity and technology.

Farmers Satisfaction

The Client Satisfaction Index (CSI) measured farmers' satisfaction with extension services and the performance of improved sorghum practices. The findings are shown in Table-5. The data depicted in the table shows that the majority of the farmers expressed high (50%) to medium (32%) level of satisfaction for performance of technology and extension services where as very few (18%) farmers expressed the lower level of satisfactions. The medium to higher degree of satisfaction with better sorghum growing techniques, links with farmers, services delivered, and so on suggested greater conviction, physical, and mental engagement in the front line demonstration. As a consequence, FLD received favourable feedback from farmers. The results are in conformity with the results of Kumaran and Vijayaraghavan (2005) [13], Tomar (2010) [23], Khadda *et al.* (2015) [10], Khadda *et al.* (2018) [9], and Bhutada *et al.* (2020) [1, 2]. The medium to higher level of satisfaction concerning services rendered, linkage with farmers and technologies demonstrated, etc. indicate stronger conviction, physical and mental involvement in the front-line demonstration which in turn would lead to higher adoption. This shows the relevance of frontline demonstration.

Table 1: Improved package of practice *Vs* Local package of practice for *Kharif* 2025-26

Sr. No.	Particulars	Improved package of practice -*Kharif* 2019-20	Local package of practice	Gap
1	Variety	CSV-55 and GJ-44	Local variety	Full gap
2	Seed rate	8 - 10 kg/ha	10-12 kg/ha	Full gap
3	Land preparation	Ploughing and three hoeing are important in-situ moisture conservation techniques that support soil aeration, water retention in the root zone, and crop water availability.	Not Follow	Full gap
4	Time of sowing	First week of June to first week of July	*Kharif*- First week of June to first week of July	No gap
5	Seed treatment	Imidacloprid 48% FS	Not followed	Full gap
6	Spacing	45 x 15cm	Not maintained broad casting	Full gap
7	RDF	NPK: 80:40:00 kg/ha, half Nitrogen, full phosphorus applied as basal and remaing half nitrogen 30 - 35 DAS.	Imbalanced use of fertilizer	Partial gap
8	Weed Management	1 hoeing and 1 hand weeding	Not done	Full gap
9	Plant protection	Use of carbofuron and immectinbenzoate	Not done	Full gap

Table 2: Details of Crops, Variety, Nos. Front Line Demonstrations conducted

Crop	Variety	Nos. of FLD	Name of villages	Nos. of Farmers	Area (ha)
***Kharif* - 2025-26**					
Sorghum	CSV-55	25	Nana Pipariya & Boriya	25	10
	GJ-44	25		25	10
Total		50		50	20

Table 3: Results of Grain yield demonstrations under FLD *Kharif* 2025-26

Year	Sorghum variety	Grain yield (Kg ha^{-1})		Per cent increase over local	Potential of grain yield (Kg ha^{-1})	Extension gap (Kg ha^{-1})	Technology gap (Kg ha^{-1})	Technology index (%)
		Improved Technology	Local practice					
Kharif-2025-26	CSV-55	2110	1820	19.25	2631	349.30	462.02	17.56
	GJ-44	2170	1820	16.08	2734	290.28	621.21	23.61
Average		2140	1820	17.665	2682.5	319.79	541.615	20.585

Table 4: Results of Fodder yield demonstrations under FLD *Kharif* 2025-26

Year	Sorghum variety	Fodder yield (Kg ha^{-1})		Per cent increase over local	Potential of grain yield (Kg ha^{-1})	Extension gap (Kg ha^{-1})	Technology gap (Kg ha^{-1})	Technology index (%)
		Improved Technology	Local practice					
Kharif-2025-26	CSV-55	6130	5550	13	16084	715	9685	12.69
	GJ-44	6400	5680	19	11970	1052	5843	18.91
Average		6265	5615	16	14027	883.5	7764	15.8

Table 5: Extent of farmer's satisfaction of extension services rendered

S. No.	Satisfaction	Frequency	Percentage
1	High	25	50%
2	Medium	16	32%
3	Low	9	18%

Conclusion

Based on the observation on various aspects it may be concluded that the grain sorghum varieties CSV-55 and GJ-44 was found to be superior in terms of grain yield and stover yield over local variety. After realizing the potential of grain sorghum varieties CSV-55 and GJ-44, farmers are showing their interest to grow CSV-55 and GJ-44 in place of traditional ones. The impact of front-line demonstration was also analyzed which showed that there was a significant improvement in knowledge level and satisfaction on the part of farmers.

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