Extension Journal

International Journal of Agriculture Extension and Social Development

Performance assessment of pearl millet (*Pennisetum glaucum* L.) variety ABV-04 through cluster front line demonstrations under rainfed semi-arid regions of Andhra Pradesh

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DOI: https://doi.org/10.33545/26180723.2025.v8.i1Sa.1513

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Abstract
In a concerted effort to enhance productivity of rainfed agriculture and nutritional outcomes, Krishi Vigyan Kendra, Banavasi, initiated Cluster Front Line Demonstrations centered on nutri-cereals, particularly the performance evaluation of pearl millet variety ABV-04 in ten farmer's holdings in the Kurnool district of Andhra Pradesh over two consecutive *Kharif* seasons during 2019 and 2020.ABV-04 and ICTP 8203, two improved pearl millet varieties, were compared with a locally cultivated farmer's variety. Over two years of evaluation, the pooled results revealed that the ABV-04 (1833 kg ha^{-1}) produced more seed yield than the local variety (1241 kg ha^{-1}) and ICTP-8203 (1377 kg ha^{-1}), with yield improvements of 47.7% and 33.1%, respectively. The panicle length recorded highest in ABV-04 (33.3 cm) when compared with ICTP -8203 (27.8 cm) and local variety (22.3 cm). 100 seed weight was also recorded highest in ABV-04 (4.5 gm) as compared to ICTP-8203 (3.4 gm) and local variety (3.1 gm). With ABV-04 variety, the average net income was greater Rs. 22337 /- per ha and it was 112.87 *per cent* higher than farmers practices (Rs. 10493/- per ha). The benefit cost ratio under demonstration package is higher (2.79) than farmers practices (1.75). The results of this study, clearly indicated that the improved pearl millet biofortified variety ABV-04 is the best substitute for the local variety in the state of Andhra Pradesh under rainfed areas. The grains of ABV 04 are high in iron (70.0 ppm) and zinc (63.0 ppm), which may aid in nutritional security, particularly for people living on marginal lands.

Keywords: Nutri-cereals, pearl millet, ABV-04, cluster front line demonstrations, B:C ratio

1. Introduction
Pearl millet, scientifically known as *Pennisetum glaucum*, is a warm-season grain crop that is widely cultivated in arid and semi-arid regions of Africa and Asia. It is rich in dietary fibre, photochemical and micronutrients hence they are termed as "Nutri-cereals". Pearl millets are rich in vitamin B, potassium, phosphorus, magnesium, iron, zinc copper and manganese. It is gluten free grain and is the only grain that retains its alkaline properties after being cooked which is ideal for people with wheat allergy (Chauhan *et al.,* 2015) [3]. Pearl millet plays a crucial role in food security and nutrition in many parts of the world, especially in regions where other cereal crops may not thrive due to adverse environmental conditions. Its resilience to drought and heat makes it an essential crop in the face of climate change and water scarcity.

Pearl millet is highly nutritious and a good source of carbohydrates, protein, and dietary fiber. It is rich in important minerals like iron, magnesium, and phosphorus. The amino acid profile of pearl millet is better than that of sorghum and maize and is comparable to that of wheat, barley and rice (Hadimani *et al.,* 1995, Abdalla *et al.,* 1998) [4, 1]. India is one of the largest producers of pearl millet in the world, followed by several African countries. Pearl millet, also known as bajra in India. Among major producing states of India, Andhra Pradesh is major producer of pearl millet. In kurnool the area under pearl millet is 3306 ha with 3445 Mt of production in 2023 and productivity of 1550 kg/ha (Anon., 2023) [2]. Pearl millet is a drought-resistant cereal crop that thrives in arid and semi-arid regions, making it suitable for cultivation in many parts of Andhra Pradesh where water availability is limited. While pearl millet is well-suited to the climate of Andhra Pradesh, it can still face challenges such as non availability of high yielding varieties. Pearl millet plays a vital role in the agriculture and food security of Andhra Pradesh, especially in regions with limited water resources and challenging climatic conditions. Farmers in the state continue to adopt improved cultivation practices to enhance pearl millet yields and contribute to the food and nutritional security of the region.

Keeping this in view, Krishi Vigyan Kendra, Banavasi located in Kurnool district of Andhra Pradesh has introduced high yielding pearl millet variety ABV-04 in comparison with ICTP-8203 and local variety by conducting Cluster Front Line Demonstrations in nutri cereals initiated by NFSM. As a part of demonstrations, improved/recommended package of practices like seed

treatment, weedicide application, STBF (Soil test based Fertilizer Application) and real time pest and disease management practices were suggested and implemented. ABV-04 variety developed by Agricultural Research Station, Anathapuramu of Acharya N G Ranga Agricultural University

Cluster Front Line Demonstrations (FLDs) in nutri-cereals refer to a strategic approach in agriculture where demonstrations are conducted in clusters or groups of farmers to showcase and disseminate improved agricultural practices, technologies, and varieties related to nutri-cereals. The scheme is implemented in a mission mode through a farmer centric approach. These demonstrations are conducted under the close supervision of scientists of Krishi Vigyan Kendra, SAUs and their Regional Research Stations.

Materials and Methods
Cluster Front Line Demonstrations in Nutri-cereals were conducted at four blocks (Pattikonda, Kodumuru, Adoni and Yemmiganur) in the western part of Kurnool district, Andhra Pradesh. These demonstrations were conducted at ten locations during *kharif* season of two consecutive years (2019 and 2020). The size of each FLD plot was 0.2 ha. In order to minimize cultivation costs in demonstration fields, a series of scientific interventions were employed. These included seed treatment, soil test-based fertilizer recommendations, integrated nutrient management, integrated pest management, and integrated disease management practices were implemented in demonstration additionally, to the introduction of improved crop varieties.

The improved pearl millet biofortified variety ABV-04 was selected for these demonstrations and distributed as critical input to the beneficiary farmers. The salient features of pearl millet varieties were given in the Table.1

The assessment was conducted to study the performance of improved varieties under recommended management practices in terms of its yield and cost economics. These varieties were compared with popular variety ICTP-8203 and locally adopted variety. Apart from demonstrations, training programmes were also conducted to the farmers on integrated crop management practices. During two years of assessment the observations such as panicle length (cm), test weight (g), yield (kg ha^{-1}), net returns and benefit cost ratio were recorded.

The results obtained during two years were analyzed using appropriate statistical tools *viz.,* mean, standard deviation, and the results were concluded at the respective levels of significances between means ($p < 0.05$). The mean values of panicle length, test weight and yield were calculated in 2019, 2020 and pooled data of two years. The technology gap, extension gap and technology index were calculated for ABV-04 variety compared to locally grown variety as per Samui *et al.,* 2000 [8]

Technology gap = Potential yield – demonstration yield
Extension gap = Demonstration yield - farmers practice yield

$$\text{Technology index (\%)} = \frac{\text{Technology gap}}{\text{Potential yield}} \times 100$$

Table 1: Salient features of pearl millet varieties

S. No	Variety	Duration (Days)	Year of notification	Specific features
1.	ABV-04	85-90	2020	Medium maturing tall and erect plant type; Resistant to downy mildew, smut and blast diseases; tolerant to drought; Panicles are thick and compact. Grey colored obovate shaped bold sized seed and it is biofortified variety rich in Iron (70.0 ppm) and Zinc (63.0 ppm).in comparison to 45.0-50.0 ppm iron and 30.0-35.0 ppm zinc in popular varieties/hybrids
2.	ICTP-8203	85-90	2011	High yielding, Resistant to downy mildew, smut and blast diseases.
3	Local variety	85-90	2005	Locally adopted good yielder

Results and Discussion
Yield attributes
During 2019 the average highest panicle length (32.5 cm) and test weight (4.6 gm) was recorded in ABV-04 followed by ICTP -8203 (27.6 cm and 3.7 gm). The average lowest panicle length (22.9 cm) and test weight (3.2gm) recorded in local variety. Similar trend was followed in the year 2020. During 2019, an average yield of 1823 kg ha^{-1} was recorded with ABV-04 and it was 33.3%, 46.7%, higher than ICTP - 8203 (1375 kg ha^{-1}) and local variety (1242 kg ha^{-1}) respectively. During 2020, an average yield of 1844 kg ha^{-1} was recorded with ABV-04 and it was 36.1%, 48.6% higher than ICTP-8203 (1377 kg ha^{-1}and local variety (1241 kg ha^{-1}) respectively. (Table.2)

The pooled results of two consecutive years (2019 and 2020) revealed that significantly highest panicle length (33.3 cm), test weight (4.5 gm) and high seed yield (1833 kg ha^{-1}) was recorded in ABV-04 followed by ICTP-8203 and local variety, since the p-value was less than 0.05 in both the years as well as in pooled analysis (Table 2). Hence, it was concluded that there is significant difference among the pearl millet varieties with regard to yield in which improved

varieties significantly produced more yield than that of farmers' practice.

The improved varieties had shown their superior performance over locally grown variety under demonstrations conducted at farmer's field. Among the three improved varieties of pearl millet, the ABV-04 was proven its superiority in terms of yield over other varieties. These results are in accordance with Kondeti, *et al*., 2022 [7].

Cost economics
Pearl millet production costs include land preparation, other crucial inputs *viz*., seeds, fertilizers, insecticides etc., cost of harvesting, threshing and prevailing seed selling prices in the year were considered for computing the cost of cultivation, gross revenue, net income and benefit cost ratio for demonstration and farmers practices and presented in Table 1. The cost cultivation was reduced by 1,000 Rs ha^{-1} (8.0%) in demonstration fields compared to farmers practice. (Fig-1). This is because of cost reduction in fertilizer by soil test based fertilizer application, integrated pest and disease management. The ABV-04 variety exhibits resistance to downy mildew, smut, and blast, resulting in a

notable reduction in the need for plant protection chemicals. This resistance not only contributes to cost savings in cultivation but also proves advantageous in demonstration fields, where the variety's performance can be effectively showcased. The ability of ABV-04 to resist these common diseases is a valuable trait, providing farmers with an environmentally friendly alternative to chemical interventions. The highest net returns and benefit cost ratio was realized significantly high in ABV-04 followed by ICTP-8203 and local variety in both the years 2019and 2020. The average higher net income (Rs 22337/- *per* ha) and benefit cost ratio (2.8) was realized in new improved ABV-04 variety. The average lower net income (Rs 10,493/- *per* ha) and benefit cost ratio (1.75) was recorded in farmers' variety (Table 4.). The highest net returns and benefit cost ratio in ABV-04 variety is due to lowest incidence of pest and diseases, resistant drought and highest yields. The highest B:C ratio of 2.8 was reported with ABV-04 and it was 1.75 with farmers practice. The positive outcomes observed in demonstration fields are promising, potentially encouraging wider adoption of the ABV-04 variety and promoting enhanced agricultural sustainability and productivity. The best management strategies resulted in increased production and profitability when compared to traditional farming approaches. These results are consistent with results reported by Kondeti *et al.,* 2022 [7] in pearl millet FLDs of ABV 04.

Gap analysis

In addition to cost economics, other parameters like technology gap, extension gap and technology index were calculated for the demonstration with ABV-04 variety alone as it shown significant advantage over other varieties (Table 4). The technology gap of demonstrated field (ABV-04) was 177 kg ha^{-1} and 156 kg ha^{-1} during 2019 and 2020, respectively. This technology gap may be due to different management practices followed and different level of soil fertility present in the demonstrated fields. The Extension gap of 581 kg ha^{-1} and 603 kg ha^{-1} was recorded during 2019 and 2020, respectively. The extension gaps in pearl millet CFLDs highlight the need for farmers to enhance their knowledge of improved varieties and production-cum-protection technology innovations. This might be accomplished through field days, capacity building, and exposure visits among farmers having similar farming situations. The technology gap varied from 7.80 kg ha^{-1} to 8.32 kg ha^{-1}, indicating potential for increased production in future years by transferring best management techniques from research stations to farmers' fields. The technology index assesses the feasibility of better technology at the farmer level under existing local conditions. In this study, an average technology index of 8.32% was observed with ABV-04 demonstration fields during two consecutive years, indicates the feasibility of improved technology. In the rainfed semi-arid area of Andhra Pradesh, yield data from consecutive years showed that cluster FLDs had a positive impact on farmer practices for enhancing the productivity of pearl millet. Similarly, Jayalakshmi *et al.,* 2022 [6], Singh *et al.,* 2020 [9] and Jadhav *et al.,* 2022 [5] also found comparable results in cluster FLDs in Bengalgram.

Table 2: Performance of pearl millet varieties in 2019, 2020 and pooled.

Particulars	Panicle length (cm)			Test weight (gm)			Seed Yield kg ha^{-1}		
	2019	2020	pooled	2019	2020	pooled	2019	2020	pooled
ABV-04	32.5	34	33.3	4.6	4.5	4.5	1823	1844	1833
ICTP-8203	27.6	28.1	27.8	3.7	3.65	3.4	1375	1377	1377
Local variety	22.9	21.5	22.3	3.2	3.1	3.1	1242	1241	1241
SD for varieties									
ABV-04	2.0	1.2	1.8	0.40	0.42	0.41	36.1	29.5	32.8
ICTP-8203	0.96	1.09	1.2	0.30	0.24	0.26	20.2	20.1	20.2
Local variety	1.5	1.82	1.6	0.37	0.34	0.35	39.1	26.5	32.8
t-Value	3.35	3.37	3.35	3.31	3.32	3.32	3.35	3.37	3.36
p-value	0.002*	0.001*	0.004*	0.004*	0.001*	0.001*	0.002*	0.002*	0.003*

*Significantly difference at 0.05% probability

Table 4: Economics of pearl millet varieties in 2019, 2020 and pooled

Years	2019			2020			pooled		
Varieties	Gross Returns Rs ha^{-1}	Net Returns Rs ha^{-1}	BC Ratio	Gross Returns Rs ha^{-1}	Net Returns Rs ha^{-1}	BC Ratio	Gross Returns Rs ha^{-1}	Net Returns Rs ha^{-1}	BC Ratio
ABV-04	34637	22137	2.77	35036	22536	2.80	34837	22337	2.79
ICTP-8203	26140	12640	1.94	26168	12668	1.94	26154	12654	1.94
Local	23958	10098	1.75	23558	10888	1.74	23758	10493	1.75

Table 5: Gap analysis of ABV-04 variety in 2019, 2020 and pooled.

Gap analysis	Technology gap kg ha^{-1}	Extension gap kg ha^{-1}	Technology index
Years			
2019	177	581	8.85
2020	156	603	7.80
Pooled	166	592	8.32

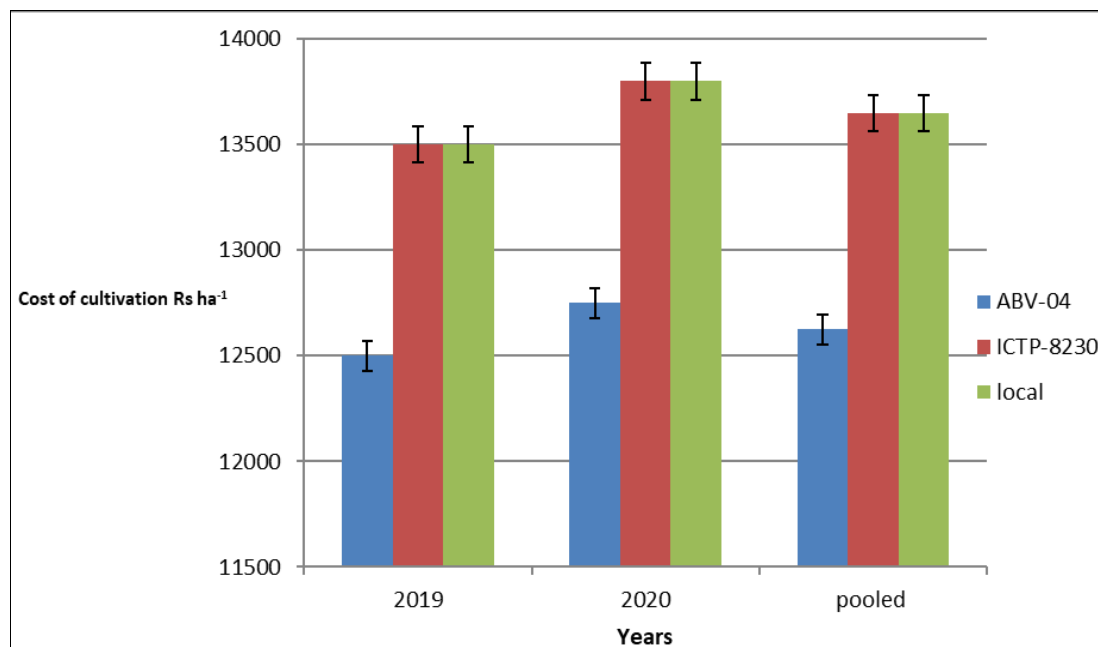ABV-04 potential yield 2000 kg ha^{-1}

Fig 1: Cost of cultivation (Rs ha^{-1}) in demonstration and farmers pratice fields

Conclusion

In Semi-Arid Zone of Andhra Pradesh, the improved pearl millet biofortified variety ABV-04 developed at AICRP on Pearl Millet, Agricultural Research Station (ARS), Ananthapuramu, outperformed the locally cultivated variety. Among the three cultivars, ABV-04 variety is a high yielding variety which has tolerance to disease and gained attention of many farmers. It can be recommended as the best alternative to local varieties under rainfed conditions. The beneficiary farmers are playing a major role in transfer of technology to the neighbouring farmers. The CFLDs has shown greater impact on the adoption of high yielding improved varieties and adjoining farmers are adopting new varieties as well as other technology interventions.

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