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Impact of Broad Bed Furrow (BBF) technology for enhancing soybean production in Jalgaon District, Maharashtra

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Abstract

Soybean productivity in rainfed regions is constrained by erratic rainfall, temporary waterlogging, and poor crop establishment. Broad Bed Furrow (BBF) technology is an effective in situ soil and water conservation practice suitable for Vertisols and medium black soils. Krishi Vigyan Kendra (KVK), Jalgaon, conducted Frontline Demonstrations (FLDs) to assess the impact of BBF sowing on soybean productivity and profitability. Results from 175 FLDs conducted during 2016-17 to 2019-20 showed that BBF sowing increased seed yield by 15-25% over conventional flat sowing. The average seed yield under BBF was 2450 kg ha^{-1}, with a mean yield advantage of 18.95%. Economic analysis showed higher net returns (₹51,424 ha^{-1}) and a benefit-cost ratio (2.90) under BBF compared with flat sowing. The study concludes that BBF technology is a sustainable and scalable solution for enhancing soybean productivity under rainfed conditions in Jalgaon district.

Keywords: Soybean, broad bed furrow, rainfed agriculture, FLD, yield, economics

Introduction

Soybean (*Glycine max* L.) is a major oilseed-cum-pulse crop in India, playing a vital role in meeting the country's edible oil demand, improving nutritional security through high-quality protein, and enhancing farm income. India is among the leading producers of soybean globally; however, average productivity remains considerably lower than the world average, particularly in rainfed agro-ecosystems (FAO, 2023; MoA&FW, 2022) [3, 5]. Low productivity is mainly attributed to erratic rainfall distribution, frequent dry spells, temporary waterlogging during heavy rainfall, and sub-optimal crop establishment during the early growth stages (Singh *et al*., 2020; Patil *et al*., 2021).

In Maharashtra, especially in Jalgaon district, soybean is predominantly grown under rainfed conditions. The crop frequently experiences alternating periods of moisture stress and excess soil moisture due to uneven rainfall patterns during the monsoon season. Inadequate soil and water management practices, uneven plant populations, and limited adoption of improved land configurations and sowing techniques further constrain yield realization (Deshmukh *et al*., 2019; Rathod *et al*., 2022) [2, 7].

Broad Bed Furrow (BBF) technology is a proven land configuration system that improves soil physical conditions by enhancing aeration, conserving soil moisture during dry spells, and facilitating rapid drainage during heavy rainfall events. Several studies have reported that BBF improves crop establishment, root growth, and nutrient uptake in rainfed crops, leading to higher yields and better water-use efficiency (Waghmare *et al*., 2020) [9]. Recognising the potential of this technology, Krishi Vigyan Kendra (KVK), Jalgaon, conducted Front Line Demonstrations (FLDs) on soybean using BBF technology to assess its impact on productivity and farm profitability under rainfed conditions.

Scope for Enhancing Soybean Productivity

Rainfed soybean cultivation is highly influenced by irregular rainfall patterns, often resulting in moisture stress during dry spells and water stagnation during periods of heavy rainfall. These conditions adversely affect crop growth and yield. The Broad Bed Furrow (BBF) system plays a crucial role in overcoming both challenges by improving field drainage and conserving soil moisture. The furrows store rainwater for use during moisture-deficit periods, while the raised beds allow excess water to drain quickly during intense rainfall. In addition, BBF ensures proper seed placement and maintains an optimum plant stand, leading to better crop establishment. Adoption of BBF technology therefore holds considerable promise for enhancing soybean productivity in rainfed regions such as Jalgaon district of Maharashtra.

Materials and Methods

Based on farmer surveys and field interactions conducted by

KVK Jalgaon and the State Agriculture Department, the following major constraints affecting soybean production were identified:

Improper plant population

- Conventional bullock- and tractor-drawn seed drills ensure row spacing but do not maintain uniform plant-to-plant spacing.
- Results in uneven germination, excess thinning, and frequent gap filling.
- Leads to poor crop stand and reduced yield potential.

Poor adoption of soil and water conservation practices

- Practices perceived as labour-intensive and time-consuming.
- Limited awareness about long-term benefits under rainfed conditions.

Limited access to improved planting technology

- Low availability of precision seed metering and BBF implements at the local level.
- Misconception among farmers that BBF technology reduces plant population, discouraging adoption.

BBF Technology Intervention

KVK Jalgaon conducted FLDs using the PKV Broad Bed Furrow Planter developed by Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola. The technical specifications are as follows (Table 01).

Table 1: Technical Specifications of the BBF Planter

Sr. No.	Component	Function / Description
1	Seed-cum-fertilizer box	Allows simultaneous and uniform placement of seed and fertilizer for better crop establishment
2	Precision seed plates	Ensure accurate seed metering and uniform plant-to-plant spacing
3	Seed tubes	Facilitate smooth and damage-free delivery of seeds into the furrow
4	Furrow openers	Form broad beds and furrows for efficient moisture conservation and drainage
5	Tines and sturdy frame	Provide strength and stability for smooth operation under varying soil conditions
6	Ground wheel with chain-gear mechanism	Synchronizes machine movement with seed metering to maintain uniform seed distribution and depth

Frontline Demonstrations

A total of 175 FLDs were conducted across 8 tehsils of Jalgaon district from 2016-17 to 2019-20, covering 70 ha.

Table 2: Year-wise details of Frontline Demonstrations on BBF technology in soybean in Jalgaon district

Year	No. of FLDs	Farmers	Area (ha)
2016-17	40	40	16
2017-18	45	45	18
2018-19	45	45	18
2019-20	45	45	18
Total	175	175	70

Results and Discussion

Effect of BBF Technology on Plant Growth and Yield

The results of Frontline Demonstrations conducted from 2016-17 to 2019-20 clearly indicated the superiority of Broad Bed Furrow (BBF) technology over conventional flat sowing in soybean. BBF-sown plots consistently recorded higher plant vigour, better crop stand, and increased pod formation. The average number of pods per plant under BBF was 122.75, which was considerably higher than that observed under farmers' practice. Improved aeration and a reduced incidence of temporary waterlogging under BBF created favourable conditions for root growth and nodulation, ultimately enhancing reproductive development.

Seed yield under BBF ranged from 2240 to 2640 kg ha^{-1} across years, with an average of 2450 kg ha^{-1}. The yield advantage over flat sowing ranged from 16.25 to 24.50 per cent, with a mean increase of 18.95 per cent. This improvement can be attributed to better moisture availability during dry spells and efficient drainage during heavy rainfall, which reduced stress during critical growth stages. Similar yield advantages of BBF sowing in soybean have been reported by Lomte *et al*. (2006) [4], Nagavallemma *et al*. (2005), [6] and Shete *et al*. (2020) [8], who observed enhanced crop establishment and yield stability under rainfed conditions.

Table 3: Effect of Broad Bed Furrow (BBF) technology on plant growth and seed yield of soybean (pooled analysis)

Year	Pods plant^{-1}	Seed yield (kg ha^{-1})	Yield increase (%)
2016-17	120	2450	16.25
2017-18	124	2470	18.50
2018-19	130	2240	16.55
2019-20	117	2640	24.50
Average	122.75	2450	18.95

Moisture Management and Nutrient Use Efficiency

BBF technology played a significant role in efficient soil moisture management. The furrows served as temporary water storage structures during rainfall events, allowing gradual infiltration and reducing surface runoff. At the same time, raised beds facilitated rapid drainage during excess rainfall, thereby preventing waterlogging—a common constraint in Vertisols of Jalgaon district. Improved soil physical conditions under BBF enhanced nutrient availability and uptake, resulting in better crop growth and higher yields.

Field observations indicated that BBF plots required fewer lifesaving irrigations than flat-sown plots, resulting in an estimated 30-40 per cent saving in irrigation water. These findings corroborate earlier reports by Astatke *et al*. (2002) [1] and Waghmare *et al*. (2020) [9], which highlighted the role of improved land configuration in increasing water-use efficiency and nutrient uptake in rainfed cropping systems.

Economic Performance of BBF Technology

Economic analysis showed that BBF technology was more profitable than conventional flat sowing across all demonstration years. The average net return under BBF was ₹51,424 ha^{-1}, with a benefit-cost ratio (B:C) of 2.90,

compared with ₹28,079 ha^{-1} and a B:C ratio of 2.07 under farmers' practice. Higher profitability under BBF was mainly due to higher yields and lower expenditure on gap filling, re-sowing, and irrigation.

Farmers earned an additional ₹10,000-15,000 ha^{-1} by adopting BBF technology, making it economically attractive and feasible. Similar improvements in economic returns from BBF adoption have been reported by Deshmukh *et al*. (2019) [2] and Rathod *et al*. (2022) [7], underscoring its suitability for rainfed soybean cultivation in Maharashtra.

Overall, the results clearly demonstrate that BBF technology enhances soybean productivity, stabilises yield under variable rainfall conditions, and improves farm profitability. The consistent performance across years indicates its potential for large-scale adoption in rainfed regions.

Table 4: Comparative economics of soybean cultivation under BBF and conventional flat sowing (pooled data)

Year	Net return (₹ ha^{-1}) BBF	B:C (BBF)	Net return (₹ ha^{-1}) Flat	B:C (Flat)
2016-17	51,150	2.87	29,650	2.06
2017-18	50,640	2.78	29,060	2.10
2018-19	46,205	2.81	26,938	2.14
2019-20	57,700	3.15	26,670	2.00
Average	51,424	2.90	28,079	2.07

Conclusion

The Frontline Demonstrations results clearly showed that Broad Bed Furrow (BBF) technology is an effective and sustainable way to improve soybean yields under rainfed conditions in Jalgaon district, Maharashtra, from 2016-17 to 2019-20. Adoption of BBF sowing significantly improved crop establishment, moisture conservation, drainage during excess rainfall, and nutrient use efficiency, resulting in a consistent yield advantage of about 15-25 per cent over conventional flat sowing. The technology also proved economically superior, recording higher net returns and benefit-cost ratios across all years of study. Improved yield stability and profitability encouraged a positive farmer response and wider acceptance of the technology. Therefore, promotion of BBF technology through training programmes, Frontline Demonstrations, and custom hiring services can play a vital role in improving soybean productivity and farm income in rainfed regions.

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