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Impact of frontline demonstrations of Broad Bed Furrow (BBF) on yield and economics of soybean (*Glycine max* (L.) Merrill) under Rainfed conditions of Northern Telangana Zone, India

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ABSTRACT

The present study was conducted at farmers fields of Adilabad district, Telangana state, India during June-October of 2018-19 to 2020-21 (for 3 seasons) to appraise the effect of Broad Bed Furrow (BBF) technology on soybean yield as well as economics. In this study, BBF planting technology was compared with the farmer's practice (Bullock drawn seed drill). In comparison to the conventional method, the sowing of soybean with BBF method found to be superior in seed yield and average soybean productivity with BBF planter was 2090 kg ha^{-1}, with a yield increase of 11.60 per cent over conventional method of sowing (1873 kg ha^{-1}). Similarly, the economics of soybean were found to be highest with BBF method in terms of gross returns (Rs. 75860 ha^{-1}) and net returns (Rs. 47512 ha^{-1}) with a B:C ratio of 2.66:1 compared to conventional method which generated the gross returns of Rs. 68096 ha^{-1} and net returns of Rs. 37964 ha^{-1} with a B:C ratio of 2.26:1.

***Key words :** Soybean, Broad Bed Furrow, Yield, Economics*

Introduction

Soybean (*Glycine max* (L.) Merrill) is globally cultivated leading oilseed crop known as golden bean for its various nutritional qualities. The major soybean producing countries are Brazil, Canada, China, India and USA. The crop was introduced in India in 1000 AD (Dupare *et al*., 2008). Globally India stands in fourth position with the cultivable area of 11.40 m ha and fifth with a production capacity of 13.78 MT (FAO STAT, 2018). The soybean seed contains about 38 to 44 per cent protein and 18- 23 per cent oil. Moreover, it contains vitamin B, fibre, iron, calcium, zinc and is flavones such as genistein and daidzein (Rizzo and Baroni, 2018). In India, soybean is a major oilseed crop in terms of area, production and economic value. It is mostly grown for the source of edible vegetable oil for human consumption, defatted soy protein products or soy protein extracts (concentrates or isolates) are an important ingredient for several processed foods and protein meal for animal feeds (Xiaoyu *et al*., 2011). In some kind of health foods, baby foods and bakery snacks, defatted soybean flour is an important industrial ingredient in making of premium category foods (Reddy *et al*., 2019). The Telangana state in India is producing 0.25 million tonnes of soybean from an area of 0.24 million hectares (Directorate of Economics and Statistics, 2017) and Adilabad district shares 39.6 per cent area with the production 38.2 per cent of total states' soybean area and production, respectively (Poshadri *et al*., 2020). Because of its lucrative nature and numerous benefits, the crop is the first and foremost option of millions of small and marginal farmers, and it plays an important role in the farming community's socio-economic transformation (Dupare *et al*., 2009). The crop is primarily grown under rainfed conditions, and rainfall distribution has a significant impact on yield (Nath *et al*., 2018). Due to adverse climatic conditions (uncertainties / delayed or unpredictable onset of monsoon/heavy storms and long dry spells), soybean yields have been affected negatively across the country in recent years. Considering these factors, farmers are advised to use Broad Bed Furrow (BBF) or Ridge and Furrow methods for planting soybean to reduce climatic risks (Anonymous, 2016). The BBF farming has many advantages with regard to water saving, mechanical weeding, fertilizer placement, and available moisture conservation, less lodging and better crop stand (Verma *et al*., 2018). In-situ water conservation makes the moisture available for the sown crop. Jat and Singh (2003) reported higher biological yield and highest net and gross return from land configuration treatment as compared to conventional system. Nagavallemma *et al*. (2005) reported that land treatments (raised sunken bed system, ridges and furrows, broad bed and furrows) increased in-situ soil moisture conservation, minimized runoff, and soil erosion and increased the yield of principal crops grown in the region. Therefore, the study was conducted at farmers fields for evaluation of BBF method of sowing in soybean in Adilabad (R), Ichoda, Bazarhatnoor and Jainath blocks of Adilabad district.

Materials and Methods

The present investigation of Frontline Demonstration (FLD) was conducted during *kharif* seasons of 2018-19, 2019-20 and 2020-21 by KVK, Adilabad at Adilabad district of Telangana state. In 2018-19, one village namely Chanda (T), Adilabad (R) block was chosen for this demonstration. During 2019-20, two villages namely Borigama of Ichoda block and Kowta of Bazarhatnur block were selected. In 2020-21, four villages namely Chanda (T) of Adilabad (R) block, Kokasmannur of Ichoda block as well as Kura and Karanji of Jainath block were selected for the demonstration. Farmers were accomplished to follow the package of practices recommended by the State Agricultural University, Telangana and (Table 1) all the practicing farmers were provided with BBF planter for sowing in their respective fields by KVK, Adilabad. Group discussion was conducted on soybean production technologies with all practicing farmers to adopt the uniform package of practice starting from field preparation, seed treatment, fertilizer management, weed management, IPM practices etc. Demonstration to practicing farmers was conducted at KVK instructional farm on seed treatment with *Rhizobium culture* @ 200 g 8 kg^{-1} seeds followed by sowing with BBF planter for effective implementation of technology. The farmer's sown soybean using BBF planter with spacing of 45 x 5 cm^2 and seed rate of 50 kg ha^{-1} (Table 1). After every 4 rows of Soybean, 30 cm width furrow was formed to drain off the excess rain water from standing crop field (Figure 1 and 2). For control plot, farmers followed conventional method of sowing viz. bullock drawn seed drill sowing with a seed rate of 75 kg ha^{-1}. The yield and economics data was collected for both demonstration and farmers practice for consecutive three years and averaged (Table 2 and 3). In the present study, technology index was operationally defined as the technical feasibility obtained due to implementation of FLD in sowing of soybean using BBF planter. To estimate the technology gap, extension gap and technology index following formula used by Rajkumar *et al*. (2019) and Raghuveer *et al*. (2020) have been used.

The data on adoption and horizontal spread of technology was collected from the farmers using semi structured interview. Data were subjected to suitable statistical methods. The following formulae were used to assess the impact on different parameters of soybean.

$$\textbf{Per cent increase in yield} = \left\{\frac{\text{Demonstration yield} - \text{farmers practice yield}}{\text{Farmers practice yield}}\right\} \times 100$$

$$\textbf{Technology Gap} = \text{Pi (Potential Yield)} - \text{Di (Demonstration Yield)}$$

$$\textbf{Extension Gap} = \text{Di (Demonstration Yield)} - \text{Fi (Farmers yield)}$$

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

Net return (Rs. ha^{-1}) = Gross return (Rs. ha^{-1}) - Total cost of cultivation (Rs. ha^{-1})

Benefit: Cost ratio = Gross return (Rs. ha^{-1})
Cost of cultivation (Rs. ha^{-1})

Additional cost (Rs. ha^{-1}) = Farmers practice cost (Rs. ha^{-1}) – Demonstration cost (Rs. ha^{-1})

Additional returns (Rs. ha^{-1}) = Demonstration returns (Rs. ha^{-1}) – Farmers practice returns (Rs. ha^{-1})

Effective gain (Rs. ha^{-1}) = Additional returns (Rs. ha^{-1}) – Additional cost (Rs. ha^{-1})

Results and Discussion

Yield performance

The seed yield of demonstration plots was higher as compared to farmers practice might be due to easy drain out of excess rain water from field through furrows. A comparison of yield performance between demonstration and farmers practice is shown in Table 2. The BBF planting technology gives higher yield compared to conventional method of sowing. It was observed that the average seed yield with the demonstration was 20.90 q ha^{-1} compared to 18.73 q ha^{-1} with farmers practice with an average increase in the yield by 11.60 per cent. Jain (2019) reported that planting of soybean with altered land configuration (broad bed furrow) resulted increase in productivity by 21.19 per cent over conventional flat bed planting. This clearly showed the effectiveness of conserving moisture by planting soybean in BBF method in reducing water stress in the event of extreme (Figure 2) as well as deficient during the crop growth period. Hanamant and Angadi (2018) reported that the planting method will increases the crop yield by its influence on seedling establishment, interception of solar energy, rooting pattern, moisture extraction pattern and also shading effect on weeds. The outcome clearly indicated that the yield of soybean could be increased over the yield obtained under farmer's practices by the adoption of BBF technology and similar results were also reported by Sharma *et al*. (2016) and Nainwal *et al*. (2019). Yield of the frontline demonstration trials and potential yield of the crop was compared to estimate the yield gaps which were further categorized into technology gap and extension gap (Hiremath and Nagaraju, 2009).

Technology Gap

As per the observations recorded (Table 2), the average technology gap was 9.10 q ha^{-1}, depicting the yield gap between demonstrated technology and potential yield which needs to be minimized by conducting FLDs. The variation if any in technology gap during the demonstration years may vary due to soil fertility, climatic condition of the area and management practices implemented by the farmers. Hence, more location specific recommendations and precise use of technology in the fields are necessary to bridge the technology gap as supported by Nainwal *et al.* (2019). The results clearly indicated the positive effects of FLDs over the existing practices toward enhancing the productivity of soybean. Similar yield enhancement in soybean in frontline demonstrations was documented by Gathiye *et al*. (2020).

Extension Gap

The average extension gap (2.17 q ha^{-1}) between BBF technology and farmer practice (Table 2) should be assigned to adoption of improved transfer technology in demonstration practices resulted in higher seed yield than conventional farmers practice was mostly due to that plant growth and yield contributing characters viz. plant population, plant height, root length, root nodules, pods $plant^{-1}$, seed yield, straw yield and harvest index (%). The results of the experiment showed that sowing in BBF promotes crop growth by reducing soil moisture stress as a result of furrow conservation and draining out excess rainwater through furrows, resulted in creating better soil physical environment and increased the availability of the nutrients throughout the crop growth period Basediya *et al*. (2020). The increase in yield with BBf technology over conventional method was also reported by Motwani and Ahish (2018) and Jain (2019). It is recommended to educate and motivate the farmers for subsequent adoption of demonstrated technology in order to minimize the extension gap by proper planning and implementation of technologies through various means of extension. The results are in conformity with Singh *et al*. (2019), Kalita *et al*. (2020) and Raghuveer *et al*. (2020), who observed that, location based problem identification and thereby specific interventions may have great implications in the enhancement of crop productivity.

Technology Index

The technology index shows the feasibility of the technology at farmer's field. The lower the value of technology index more is feasibility. The result of the present study illustrated in Table 2 revealed that the technology index value is 30.33 per cent. This value shows that there is a gap between technology developed and technology adopted at farmer's field. This might be due to the farmer perception towards the technology involving high initial costs and aberrant climatic conditions resulted in the increasing trend of technology index values during the demonstration years. Similar findings were also reported by Ramesh *et al*., 2020. Under the vagaries of monsoon, plant population mortality in soybean with tractor-drawn BBF seed drill for vertisols was reduced by 14-19 per cent compared to flat bed, resulting in yield enhancement of 18.65 per cent (Singh *et al*. 2011). The similar results were also reported by Chauhan (2012), Singh *et al*. (2019) and Khedkar *et al*. (2020).

Economics

The economics of the present study was worked out for the experimental years *i.e*., *Kharif* 2018-19, 2019-20 and 2020-21. The average data under BBF technology and farmers practice of three consecutive years (Table 3) indicates that the gross returns (Rs. 75860 ha^{-1}) were 11.40 per cent higher than bullock drawn planting (Rs. 68096 ha^{-1}). Likewise, 25.2 per cent higher net returns under the BBF technology (Rs. 47512 ha^{-1}) over traditional bullock drawn sowing method (Rs. 37964 ha^{-1}). Similarly, 5.9 per cent reduction in cost of cultivation with adoption of BBF planter by saving in seed and labour requirement. Similar results were also reported by Verma *et al*. (2017) and Basediya *et al*. (2020). The B: C ratio was higher in the BBF method (2.66) than flat bed method of sowing (2.26), as shown in Table 3. These results were supported by Ram *et al.,* 2011. The results of the experiment proved that sowing with broad bed furrow method resulted in saving the cost on seed requirement, labour requirement, better crop establishment and yield by reducing the effect of moisture stress in the soil as a result of furrow conservation and drain out of excess rain water, thus improves the soil physical environment and increasing the nutrient availability.

Further examination of the data (Table 3) showed that the demonstrated technology resulted in higher additional returns of Rs. 7764 ha^{-1} and effective gain of Rs. 5980 ha^{-1} as compared to farmers practice during the course of study. The higher additional returns and effective gain obtained under demonstration might be due to improved technology, non-monetary factors and timely operations of crop cultivation as well as scientific monitoring which finally resulted in higher yields and less input cost.

Conclusion

Soybean cultivation using the broad bed furrow (BBF) method of sowing under rainfed conditions is vital option in getting the better crop growth, yield, conserving the moisture, reduction in the cost of cultivation, saving the time and increasing the net returns over traditional flat bed method of cultivation. The results of the experiment showed that the BBF method can achieve higher productivity with a higher benefit cost (B: C) ratio of soybean cultivation in rainfed condition. The use of BBF to change land configuration is the better option in in-situ moisture conservation and to drain out the excess rainwater under rainfed cultivation in Adilabad district of Telangana. Horizontal spread of improved technologies may be achieved by the successful implementation of frontline demonstrations and various extensions activities like training programme, field day, exposure visit organized in FLDs programmes in the farmer's fields

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