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Break-even Yield and Cost of Cultivation of Different Soybean Varieties – An Analysis

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ABSTRACT

Frontline demonstrations (FLDs) on soybean production technologies and varieties are being conducted at farmer's field across the country since 1989-90 with the objective to demonstrate their impact on productivity under real farm situations. FLD's data from 2013-2017 were used to analyze the break-even yield and break-even cost in the present investigation. The results of 44,162 frontline demonstrations revealed that the planting of new soybean varieties along with adoption of improved soybean production technology enhanced the soybean yield to the tune of 26 per cent as compared to farmer's practice. The analysis indicated that the soybean break-even yield varied from 470 to 1,305 kg per ha under improved variety and 398 to 1,315 kg per ha under farmer's practice. However, the break-even cost of cultivation ranged from 20.01 to 30.61 and 19.28 to 30.80 Rs per kg under improved varieties and farmer's practice, respectively. The results envisaged that the soybean varieties had their own break-even yield and cost.

Key words: Break-even yield, break-even cost, yield gap

The commercial cultivation of soybean was initiated during early 1970s in India. Thereafter the rapid growth was observed in area and production of the crop (Chand, 2007; Sharma, 2016a) mainly due to its suitability in the cropping sequence, comparative profitability as compared to competitive crops, lower requirement of labour and other inputs, *etc*. (Sharma *et al,* 2015; Sharma, 2016a,b). The crop has helped to raise the socio-economic status of soybean farmers in central and peninsular India (Dupare *et al,* 2009; Sharma *et al,* 2016). At present, soybean has established itself as a leading oil yielding leguminous crop in the country and presently occupies premier position among the nine oilseeds cultivated in India. Although, an unparallel growth in area and production, availability of varieties with yield potential up to 3.5 t per ha and improved production technology, the national average yield remains around 1 t per ha. The major reasons for sub-optimal yield include; total dependence on rainfall, slow pace of technology transfer and its adoption, lack of awareness about production technologies in newer areas, non-availability of quality non-availability of quality seed and that too of improved varieties, imbalanced nutrition

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devoid of integrated approach, timely unavailability of agro-chemicals and other inputs, *etc*. (Dupare *et al,* 2011). In order to facilitate effective technology transfer and to achieve the targets, Government of India through Indian Council of Agricultural Research (ICAR) launched a programme during 1989-90, called Frontline Demonstrations (FLDs) on oilseeds and pulses. FLDs are being conducted at farmers' fields under the direct supervision of scientists, with the major objective of demonstrating the production potential of improved soybean technologies and varieties developed by research system for different agro-climatic regions on location specific basis under real farm situations. The ultimate aim of the programme was to increase the rate of adoption of newly released varieties and improved productivity, and thus, farmers' income. Popularization of newly released varieties has always been a concern for research institutes and extension agencies. Demonstration of potential of the variety and its profitability at farmers' fields is best way to increase the demand of seed and to bring the variety in the seed chain.

Many scholars have proposed and discussed break-even analysis for agricultural decision-making (Kay, 1986; Schmisseur and Landis, 1985; Forster and Erven, 1981; Herbst, 1976; Barnard and Nix, 1979; Giles and Stansfield, 1980). Enterprise budgeting enables the farm managers to carry-out break-even analysis, estimate cost of production, and select between competing crop production alternatives. The more common break-even yield and price relationships have been expanded to include acreage or usage levels for machinery management by some of the researchers (Herbst, 1976; Forster and Erven, 1981; Barnard and Nix, 1979), and break-even output price and yield analysis between agricultural enterprises (Casey, 1977; Herbst, 1976). While these serve as worthwhile decision-making tools, development of advanced break-even analytical procedures havebeen suggested (Giles and Stansfield, 1980; Forster and Erven, 1981). Break-even output price can be used as a simple risk management tool to evaluate the impacts of marketing decisions under price volatility. Maximum potential yield losses due to detrimental weather can be investigated with break-even yield analysis. Break-even analysis is also useful from the input side. Keeping these in view, the break-even analyses were carried out to assess the profitability of soybean varieties cultivation in different states of India.

MATERIALS AND METHODS

The pooled data from FLDs conducted from 2013 to 2017 at different centres spread over 15 states of the country was used for the analysis. A total of 44,162 FLDs (Table 1) were conducted in different states of India at farmer's field on0.4 ha each with research emanated improved soybean production technology (IT) and that were compared with farmer's practice (FP). The seed of newly released varieties (52 varieties) and critical inputs were supplied to the farmers under improved production technology. The cost of cultivation under both the treatments was determined by using the prevailing market price of inputs and outputs. The data of varieties having less than five FLDs planted for less than three years have been discarded, thus leaving 26 varieties for analysis.

Break-even (BE) analysis was used to determine the values at which price, production, output and so on are adequate enough to cover specific costs (Chambers *et al.*, 1979; Baute *et al.*, 2002; Cook *et al.*, 2012). Based on current production and marketing systems, break-even analysis was conducted for soybean production in different states of India. The minimum yield and price required matching the performance of the improved production technology and farmers practice was determined in order to cover the costs. The basic formula for break-even analysis was adapted and solved for the variables of interest was as under.

Break-even yield (kg/ha)	=	Total Cost of cultivation / Output price (Rs/kg)
Incremental Benefit cost ratio (IBCR)	=	Incremental gross returns from the demonstrated technology/Incremental cost involved in demonstrated technology
Incremental net returns	=	Net returns from IT – Net returns from FP

The percentage yield increment in improved practice for each variety over farmers' practice was calculated across the states and for the country as a whole as weighted average using number of demonstrations as weights. The cost and returns data were deflated using wholesale price index for soybean with the base 2011-12.

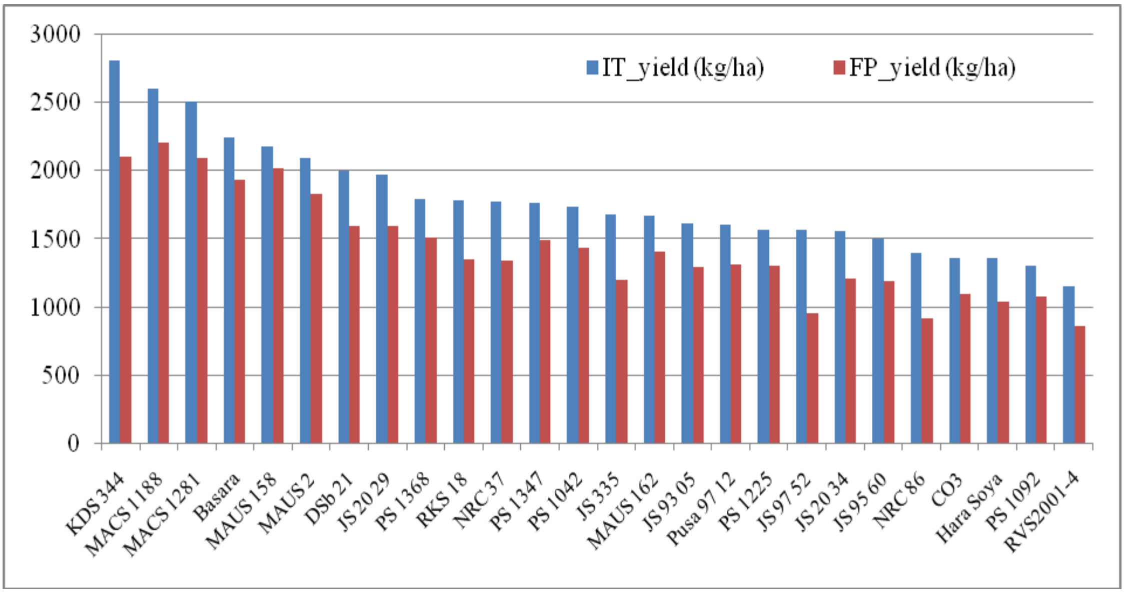
Break-even revenue and price are the minimum revenue and price of soybean that is required to match the cost of production of soybean. Total revenue is the product of yield and price. Cost of all material inputs, machines and labour inputs used were considered for analysis. Gross returns have been worked out at prevailing market price in the respective area. The data of improved technology where comparable farmers practice was not available have been excluded from the analysis. Break-even (BE) yield is the minimum yield of soybean required to match the profitability of commercial soybean. BE yield can be compared between improved technology and farmer's practice and also be used as an indicator for the competitiveness of improved production technology. In order to attempt to sell at a profit rather than taking a hit, it is important for soybean producers to know their break-even yields.

RESULTS AND DISCUSSION

A total of 52 soybean improved varieties have been demonstrated on 4,735 FLDs, which were conducted across the country during the period under study. Of these, 162 FLDs were taken for analysis and remaining data have not been included due to non-availability of comparable farmers practice data or less data points for some of the varieties. The highest number (>2300) of FLDs were conducted using variety JS 95-60 followed by JS 93-05 and JS 335 (Fig. 1). Of the 52 soybean varieties, 34 were demonstrated on more than 10 farmer's field, whereas demonstrations conducted with remaining varieties were below ten during the five year period. Moreover, some of the varieties demonstrated in one year only were also not considered for analysis. Among the varieties, the highest soybean yield was recorded with variety KDS 344 under IT and the lowest yield was associated with variety RVS 2001-4. Out of 26 varieties, three (KDS 344, MACS 1188 and MACS 1281 under IT) yielded more than 2,500 kg per ha, four (MAUS 2, MAUS 158, Basara) produced in between 2,000 to 2,500 kg per ha, 13 yielded between 1,500 to 2,000 kg per ha, and yield of 6 ranged between 1,000 to 1,500 kg per ha. The improved soybean varieties substantially improved the soybean productivity to the tune of 8 to 64 per cent as compared to the farmer's practice, and generated higher net income to the tune of 15 to 166 per cent under IT as compared to farmers' practice (Fig. 1). Under farmer's practice, a similar trend was noted in terms of higher yield realized. Similar results were also reported by Billore *et al*. (2005 and 2009) and Joshi *et al*. (2004).

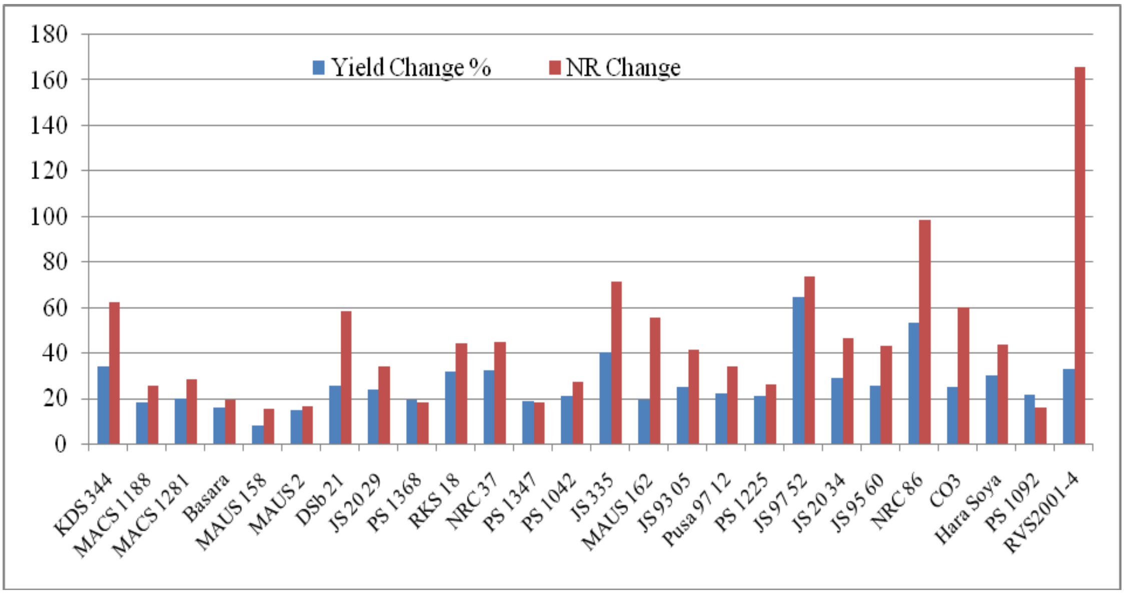
On an average, an increase of 26 per cent (1,636 kg/ha) could be achieved, which was about 60 per cent higher than the national average productivity (1,000 kg/ha), and productivity with improved technology (1,846 kg/ha) during normal year (*kharif* 2016). Even if we consider the predicted 80 per cent possibility (Cassman, 1999) of bringing FLDs Frontline Demonstration performance as ground reality or bridging the yield gap, the productivity of above 1,500 kg per ha can be achieved. This leads to belief that from the present area of around 11.25 million hectares in the country (last five year average), an additional production of 5.85 million tonnes of soybean can be realized with adoption of available improved technology against 10.98 million tones achieved on an average during last five years.

Adoption of improved soybean varieties not only enhances the yield realization, but also helps in improving monitory returns to the farmers. Change in net returns under IT over farmers' practices (Fig. 2) and benefit cost ratio (BCR) from adoption of improved soybean varieties over farmers' practice (Fig. 3) revealed that farmers can earn net returns to the tune of Rs. 18,600 to Rs. 54,400 per ha across different varieties under IT and Rs. 9,700 to Rs. 39,100 per hectare under farmers' practice. The maximum net returns were recorded with variety KDS 344. The improved production technology was found economically viable (Mathur and Gupta, 1985; Thakur *et al*., 1998; Joshi *et al*., 2004). The returns to investment determine the profitability and thus, the extent of adoption of technology. The benefit cost the profitability and thus, the extent of adoption of technology. The benefit cost ratio was in the range of 1.53 to 2.89 across the varieties, indicating that adoption of improved soybean varieties generates sufficient returns over investment and is profitable. The variation in net returns and BCR across varieties was mainly on account of differences in practices adopted by farmers. The incremental net benefit cost ratio from adoption of IT over farmers' practice was found to be in the



IT-improved technology, FP-Farmer's practice

Fig. 1. Average yield achieved for different varieties under FLDs for the period 2013-2017

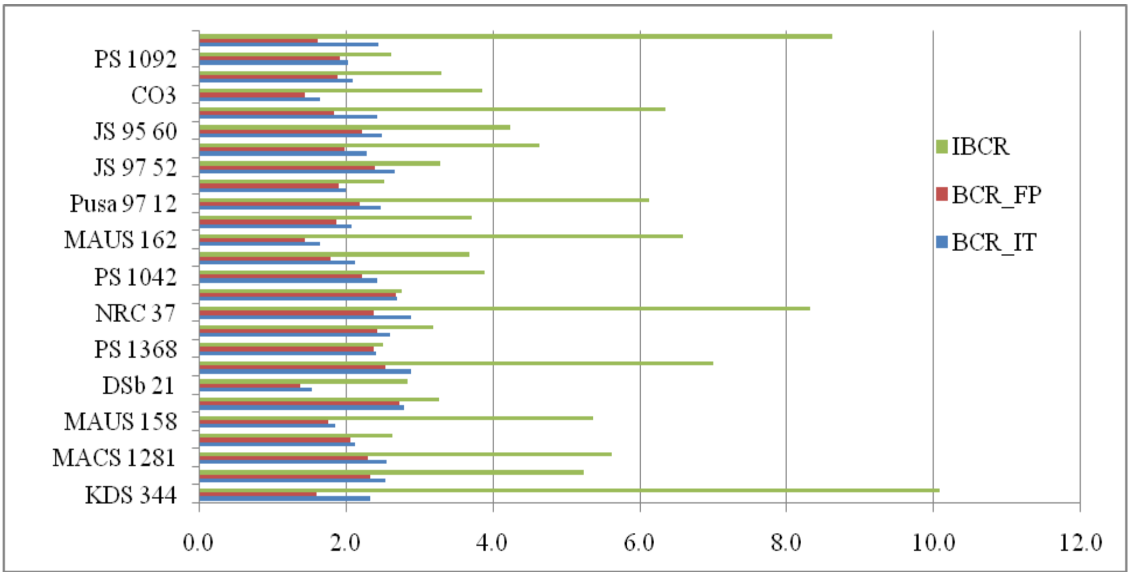


NR-Net returns

Fig. 2. Percentage change in average yield and net returns under IT over FP for the period 2013-2017

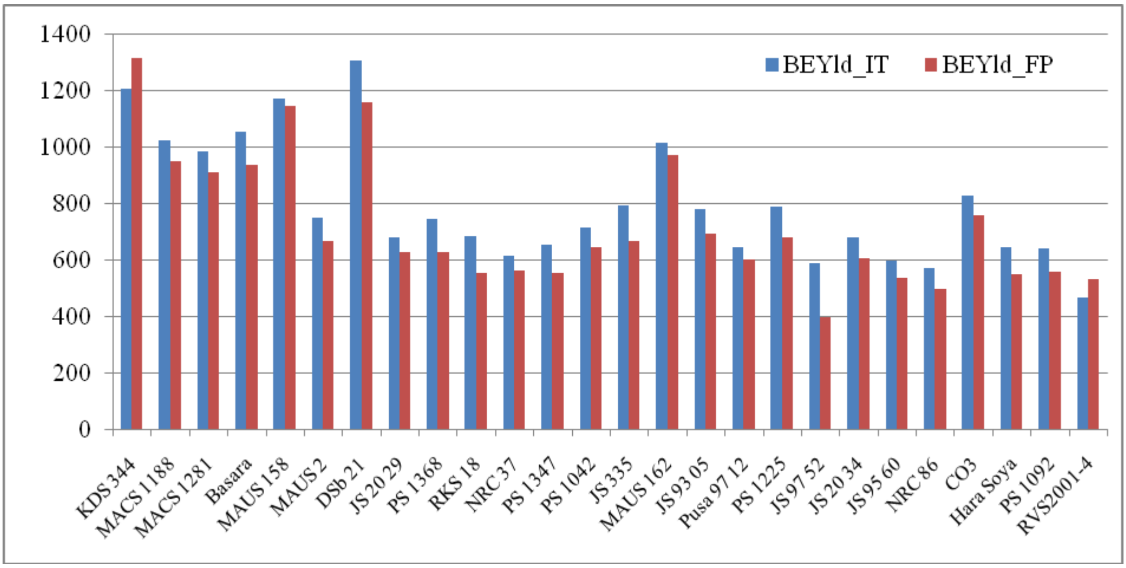
range of 2.51 to 10.07, indicating that the adoption of improved soybean production technology generated about 2.5 to 10 times higher net returns as compared to farmers' practice.

Break-even yield analysis reveals potential profit losses if yields and premiums are below the critical thresholds. Based on the cultivation cost and selling price of soybean, the break-even yield was worked out (Fig. 4). The results of analysis revealed that the break-even yield, on an average basis, varied from 470 kg per ha (RVS 2001-4 to 1,305 kg per ha (DSb 21) under IT. The overall average soybean yield needed to break-even was 793 kg per ha to receive positive returns under improved soybean technology. However, in farmers practice, average break-even yield varied from nearly 398 kg per ha to more than 1,315 kg per ha at 2011-12 prices. The break-even yield points, *i.e.* 793 and 719 kg per ha indicated that these yield levels showed no profit no loss in soybean cultivation and for profitable soybean production yield should be higher than this break-even yield. The results revealed that the break-even yield level was higher under improved technology than farmers practice. Similar results were also reported in a study by Mayata *et al*., (2014). The average break-even cost of production of soybean varieties varied from 20.01 to 30.61 Rs per kg under IT where as it ranged from 19.28 to 30.80 Rs per kg under farmer's practice at 2011-12 prices (Fig. 5).



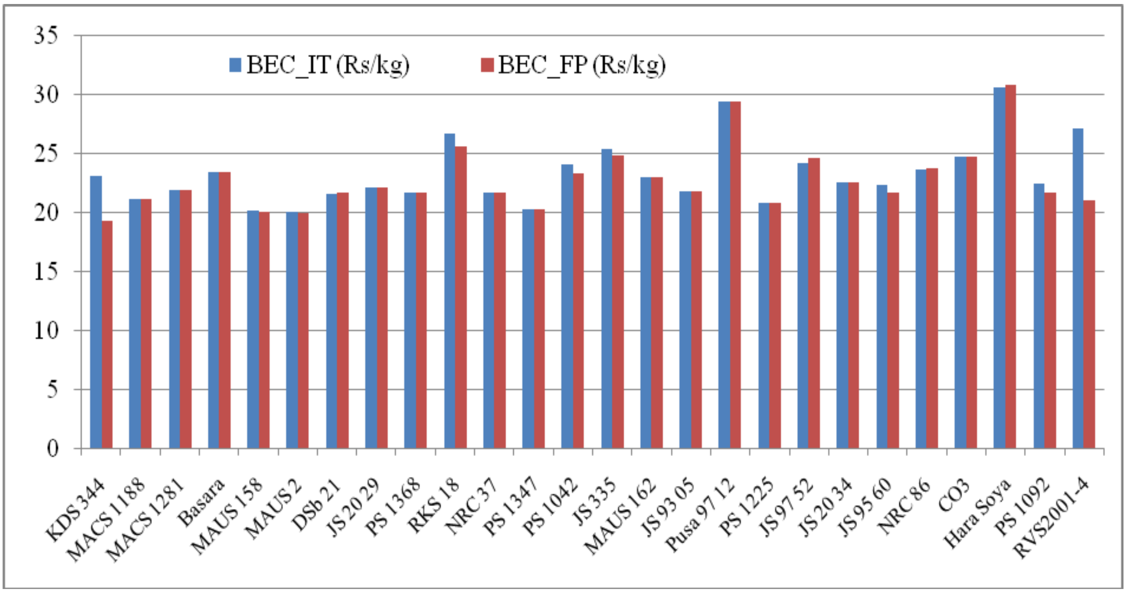
ICBR-Incremental benefit cost ratio, BCR-Benefit cost ratio, IT-improved technology, FP-Farmer's practice

Fig. 3. Benefit: cost ratio under IT and FPs and IBCR from production of soybean



BE-Break-even, IT-improved technology, FP-Farmer's practice

Fig. 4. Break-even yield of soybean varieties under FLDs



BE-Break-even, IT-improved technology, FP-Farmer's practice

Fig. 5. Break-even cost of production of soybean varieties under FLDs

Careful selection of recommended variety and their testing in the local environments and production systems are needed if farmers are to consider the adoption of improved soybean varieties at current market conditions. Also, as commodity prices fluctuate, additional break-even analyses must be conducted to accurately estimate future profitability from soybean production. Adequate testing will ensure optimal yields for the growers and desired soybean quality for the processors.

In summary, any yields above 793 and 719 kg per ha under improved soybean varieties and farmers practice for soybeans sold at harvest represented profitable income over break-even prices. Achieving consistent production at these high levels without causing environmental damage requires improvements in soil quality and precise management of all production factors in time and space.

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