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RESEARCH ARTICLE

THE YIELD GAP ANALYSIS AND IMPACT OF TECHNOLOGICAL CHANGES IN SOYBEAN PRODUCTION IN MAHARASHTRA STATE

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ABSTRACT

Soybean possesses a very high nutritional value along with high yield potential. It contains about 40% high quality protein and 20% oil. The present study was carried out to know,the yield gap analysis and impact of technological changes in soybean production in Maharashtra state. The technological and input use difference between for soybean contributed to form the total productivity difference of 25.78 per cent, whereas, the contribution of technological change to total change in output alone was estimated to be 17.40 per cent. This implies that, with the present level of resource use by the farmers, the returns could be increased by about 17 per cent, if proper technologies adopted thereof.With the objective of knowing the gap between the experimental farm yield and potential farm yield on one hand and actual yield on the sample farms on the other, yield gap in soybean was estimated. The performance of frontline demonstrations confirms that, there is a wide gap between demonstrations farm yield and actual yield on farmers' field. This gap can be filled by dissemination of technologies of soybean cultivation by various extension ways including the block/village demonstrations in larger area, timely supply of quality inputs, technical guidance, appropriate policy development and strengthening execution at grass-root level, etc.

INTRODUCTION

Oil is one of the important factor in balanced food diet provides fats which are necessary for human being. Edible oil is produced by crushing the oilseeds, viz., groundnut, sesame, linseed, sunflower, safflower etc. In India, there are many states and the people from the different states have different tastes. There is difference in consumption of food, also. According to their customs and taste, they consume different types of edible oils. The persons of Kashmir consume more oil than ghee because to them, oil is having more potential or essential for the physical health and beneficial than ghee. Major avenues for future to increase in oilseeds production are expected to come from the enhancement in productivity of oilseed crops. To realize this expectation, a proper mix of technologies and government strategies need to be put in place. Given the difficulties involved in increasing the area under oilseed crops, a combination of land-saving technologies involving high-yielding varieties and efficient crop management need to be adopted. The unrealized yield due to lack of adoption of proper nutrient management has to be brought out. In this backdrop, adoption of integrated pest management, balanced and integrated crop nutrition managements, etc. should be stressed for oilseed crops. The advantage of mechanization in oilseed crops is a least understood and often neglected area. As a major sector, agriculture continues to be the life line for millions of farmers in India. Change in the production and productivity in the field of agriculture is possible in India due to a massive diversion from the traditional agriculture to new commercial agriculture. In the post-green revolution era, the agricultural production was targeted through change in area under cultivation, increasing cropping intensity and increasing productivity per unit area.Though first two strategies are the state related subjects, the improvement in productivity mainly depends on the infrastructural, technological, institutional and environmental factors. A number of government sponsored programs were directed towards the improvement in the productivity in agriculture in the form of introduction of new technologies in agriculture, which led to the green revolution in the mid-sixties. Green revolution in India has been the cornerstone of India's agriculture achievement, transforming the country from one of food deficiency to self-sufficiency. Though India has competent agricultural research and extension systems, yet the adoption of technologies by farmers

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are far from satisfactory levels. In this direction, an attempt has been made to study the, "The yield gap analysis and impact of technological changes in Soybean production in Maharashtra state."

MATERIALS AND METHODS

The investigation was conducted in selected districts of Maharashtra state. As there is no production of soybean due to unsuitable weather conditions in Konkan region, hence, only three regions viz., Western Maharashtra, Marathwada and Vidarbha were selected for the study of soybean where the area under these oilseed crops is concentrated. Ahmednagar (Western Maharashtra), Latur (Marathwada) and Amravati (Vidarbha) districts were selected on the basis of maximum area. Two tahsils from each district were selected on the basis of maximum area under soybean. Based on availability of samples, two villages from each tahsil were selected. In all, twelve villages for soybean were selected for the study. for soybean, 12 farmers were randomly selected from each village, on the basis of total size of holdings of the selected sample cultivators. Thus, total 144 farmers were selected for the study of soybean. The data were collected with the help of interview schedule using pre tested structured schedule by personal interview method. As there is no production of soybean due to unsuitable weather conditions in Konkan region, hence, only three regions viz., Western Maharashtra, Marathwada and Vidarbha were selected for the study of soybean where the area under these oilseed crops is concentrated.

Technical Change: Impact on input use and output growth

The adoption of technologies brings about changes in output, employment and factor shares. For determining the structural break in production relations, the production function was proposed as relevant conceptual framework. Production function analysis was used to find out the input–output relationship, marginal value productivity of inputs used and also to examine the resource use efficiency in soybean production. The production function relationship refers to technical relationship between the factors of production and the output. It provides the information on expected variation in the quantity of yield when certain quantities of inputs are used in production.

The transformation of a set of inputs into output which was described by a production function, can be written for soybean production as,

$Y = f(X_1, X_2, X_3, - - - - - Xn)$

Where;

Y = Dependent variable

$X_1, X_2, X_3, - - - - - Xn$ = Independent variables.

The Cobb-Douglas production function framework has been used in the present study to measure the returns to scale and to interpret the elasticity coefficients with relative ease.

$$Y= b_0 X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} X_7^{b7} e^{DX8} e^u$$

In logarithmic linear form the above function can be written as,

$$\text{Ln } Y= \text{Ln } b_0+ b_1\text{Ln } X_1+ b_2\text{Ln } X_2+ b_3\text{Ln } X_3+ b_4\text{Ln } X_4+ b_5\text{Ln } X_5+ b_6\text{Ln } X_{6+} b_7\text{Ln } X_{7+}D\ X_6+u$$

Where,

Y	=	Output of main produce (q/ha)
a	=	Intercept term (Scale parameter)
X_1	=	Per hectare use of human labour (man days)
X_2	=	Per hectare use of bullock labour (pair days)
X_3	=	Per hectare use of machine labour (hr)
X_4	=	Per hectare use of manures (q/ha)
X_5	=	Nitrogen application (kg/ha)
X_6	=	Phosphorus application (kg/ha)
X_7	=	Potassium application (kg/ha)
D	=	Intercept dummy which takes value '1' if it is high technology adoption farm and '0' otherwise
e^u	=	Error term

$b_{1,}b_{2,}b_{3,}b_{4,}b_{5,}b_6$ and b_7 = Regression coefficients of human labour, bullock labour, machine labour, manures and fertilizers (N,P,K), respectively.

The function was fitted for two separate groups of farmers who were classified based on the level of technologies adopted in their farms. The farmers were post classified into low technology adoption group and high technology adoption group based on the level of adoption of technologies in soybean production. Parameters of regression equation were estimated by the Ordinary Least Square (OLS) method using the logarithmic form. All the seven coefficients taken together which measures the total percentage change in output for a given percentage change in inputs.

Structural break in production relation

To identify the structural break if any in the soybean production relations with the high adoption in soybean production, output elasticities were estimated by Ordinary Least Square (OLS) method by fitting log linear regression separately for, low technology adopters and high technology adopters. The pooled regression function was run in combination with, low and high technology adopters including technology as dummy variable with value 'one' for high adopters group and 'zero' for low adopters.

The following four log linear estimable forms of equations were used examining the structural break in production relation;

a) Low technology adoption group
b) High technology adoption group
c)
d) Aggregate of low and high technology adoption group (without dummy variable)
e) Aggregate of low and high technology adoption group (with dummy variable) D = 1, for "high technology adoption group" and D = 0, for "low technology adoption group"
f)

$$\text{Ln } Y_1= \text{Ln } A_1+b_{11}\text{Ln } X_{11}+ b_{21}\text{Ln } X_{21}+ b_{31}\text{Ln } X_{31}+ b_{41}\text{Ln } X_{41+} b_{51}\text{Ln } X_{51+}U\bar{1}$$

$$\text{Ln } Y_2= \text{Ln } A_2+b_{12}\text{Ln } X_{12}+ b_{22}\text{Ln } X_{22}+ b_{32}\text{Ln } X_{32}+ b_{42}\text{Ln } X_{42+} b_{52}\text{Ln } X_{52+}U\bar{2}$$

$Ln\ Y_3 = Ln\ A_3 + b_{13} Ln\ X_{13} + b_{23} Ln\ X_{23} + b_{33} Ln\ X_{33} + b_{43} Ln\ X_{43} + b_{53} Ln\ X_{53} + U\bar{3}$

$Ln\ Y_4 = Ln\ A_4 + b_{14} LnX_{14} + b_{24} LnX_{24} + b_{34} LnX_{34} + b_{44} Ln\ X_{44} + b_{54} Ln\ X_{54} + b_4 D + U_4$

Where,

$\bar{1}, \bar{2}$ and $\bar{3}$ = Low adopters, high adopters and pooled production function

bi's = Individual output elasticities

Chow's test was used to identify whether the parameters governing the production relations in the "low adopters" are different from that of "high adopters". The standard error estimated for dependent variables were used to compute the 'F' ratio. The computed 'F' value was compared with number of variables at degrees of freedom (n+m-2) at appropriate level of significance, where, 'n' represents the sample size of low adopters and 'm' represents the sample size of high adopters. Similarly, the regression coefficient of dummy variable and computed 'F' value for the pooled regression function was calculated to examine the structural break between low adopters and high adopters in soybean production.

Sources of output growth

Technical change in the production function can be defined as a change in the parameters of the production function or creation of new production function. For any production function, the total change in output is brought about by the shifts in the parameters of production function and the changes in the volume of inputs. A rise in the total output by 'high' adopters over the 'low' adopters with the use of same level of inputs was attributed to the technical change. This change in total output due to technology was measured by changes in scale (intercept) and slope (elasticities) parameters. Out of this total change, shift in the intercept has measured the neutral component of the technical change and the shift in the slope parameters (ai and bi's) has measured the non–neutral component of the technical change which together constitutes technological contribution to the difference in output by the 'low' and 'high' adopters. The total change in output was decomposed into the factors of technology and changes in the quantities of inputs. (Bisliah,1977).

$Ln\ (Y_2/Y_1) = [Ln\ (A_2/A_1)] + [(b_{12}-b_{11})\ Ln\ X_{11} + (b_{22}-b_{21})\ Ln\ X_{21} + (b_{32}-b_{31})\ Ln\ X_{31} + (b_{42}-b_{41})\ Ln\ X_{41} + (b_{52}-b_{51})\ Ln\ X_{51} + (b_{62}-b_{61})\ Ln\ X_{61} + (b_{72}-b_{71})\ Ln\ X_{71}] + [\{b_{12}\ Ln\ (X_{12}/X_{11})\} + \{b_{22}\ Ln\ (X_{22}/X_{21})\} + \{b_{32}\ Ln\ (X_{32}/X_{31})\} + \{b_{42}\ Ln\ (X_{42}/X_{41})\} + \{b_{52}\ Ln\ (X_{52}/X_{51})\} + \{b_{62}\ Ln\ (X_{62}/X_{61})\} + \{b_{72}\ Ln\ (X_{72}/X_{71})\}] + [U_2 - U_1]$

The decomposition of the above equation was calculated by decomposing the logarithm of the ratio of 'high' to 'low' adopters. It was given the approximate measure of percentage change in output with by high adopters. This equation was the output decomposition model used for decomposition of total output into its causal components, i.e. technological change and increased level of inputs used.

- The above equation was decomposing to calculate the total difference in per hectare yield between 'low' and 'high' adopters (on left hand side of equation) into;
- Neutral technological change (first bracketed expression on right hand side)
- Non-neutral technological change (second bracketed expression on right hand side)
- Changes in the level of inputs (third bracketed expression on right hand side)

The first bracketed expression on the right hand side was given to measure a percentage change in output due to shift in scale parameters of the production function. The second bracketed expression represents the sum of the arithmetic changes in output elasticities, each weighted by logarithm of volume of that input used under high technology, as a measure of change in output due to shifts in slope parameters (output elasticities) of the production function. The third bracketed expression represents the sum of the logarithm of the ratio of input used by high adopters to input used by low adopters, each weighted by the output elasticity of that input under by high adopters. This expression represents a measure of change in output due to changes in the inputs used per unit, given the output elasticities of these inputs by high adopters. The last bracketed expression represents the difference in error terms.

Technological gap analysis

The yield gap is the difference between the potential yield and actual yield of crop. The actual yield was the yield reported by sample farmers in the state or district and the information on potential yield were obtained from Demonstrations plots (FLD's) of research stations.Yield gap were estimated by using the methodology developed by International Rice Research Institute (IRRI), Manila, Philippines. The methodologies for the estimation of different types of yield gap were given as,

1. **Yield Gap-I = Y_p-Y_d**

   Where,

   Y_p= Potential yield (i.e. Yield realized at Research station)
   Y_d= Yield realized on Demonstration plots of SAU's

2. **Yield Gap-II = Y_d-Y_a**

Where,

Y_p= Yield realized on Demonstration plots of SAU's
Y_d= Actual average yield (i.e. Yield realized on sample farms)

RESULTS AND DISCUSSION

Decomposition analysis

The adoption of technologies brings about changes in output, employment and factor share for determining the structural break in production relations, accounting for the sources of output growth and evaluating the effect of new technology. Cobb-Douglas production function was fitted for two separate groups of farmers who were classified on the basis of level of technology adoption index. Thus, the farmers were post classified into low technology adoption group and high technology adoption group.

Cobb-Douglas production function for soybean was employed as below.

$$Y = aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}X_6^{b6}X_7^{b7}e^{DX8}e^{u}$$

Where,

Y	=	Output of main produce (q/ha)
a	=	Intercept term (Scale parameter)
X_1	=	Per hectare use of human labour (man days)
X_2	=	Per hectare use of bullock labour (pair days)
X_3	=	Per hectare use of machine labour (hr)
X_4	=	Per hectare use of manures (q/ha)
X_5	=	Nitrogen application (kg/ha)
X_6	=	Phosphorus application (kg/ha)
X_7	=	Potassium application (kg/ha)
D	=	Intercept dummy which takes value '1' if it is high technology adoption farm and '0' otherwise
e^u	=	Error term

b_1 to b_7 = Regression coefficients

Structural break in production relation

To identify the structural break if any in the soybean production relations with the high adoption in soybean production, output elasticities were estimated by Ordinary Least Square (OLS) method by fitting log linear regression separately for, low technology adopters and high technology adopters.

The pooled regression function was run in combination with, low and high technology adopters including technology as dummy variable with value 'one' for high adopters group and 'zero' for low adopters. Chow's test was employed to identify the parameters governing the production relations in the "high adoption group" are different from that of "low adoption group". The 'F' Chow's test was significant indicating that, the corresponding parameters in soybean were not same. The calculated 'F' value for soybean (89.42) was greater than 'F' calculated value at 5 per cent level of significance.

Geometric mean levels of soybean output and inputs used in production

The per hectare estimates of geometric mean levels of soybean output and the level of different inputs used in soybean production were worked out and presented in the Table 1. It is clear from the table that, the soybean production in high adopters farms was 25.78 per cent more than in low adopter farms. With regard to input use, the 'high adopters' tended to use 81.43, 20.96, 42.47 and 9.85 per cent more manures, nitrogen, phosphorus and potassium use in soybean production, respectively. However, the other input component viz.; human labour, bullock labour and machine labour, etc. were used at lower side than that of low adopters. The input components especially human labour, bullock labour and machine labour were used less than that of the low adopters. This was mainly because of that, the use of labours, bullock and machinery were used efficiently by large adopter farms.

Decomposition of output growth

Output Decomposition Analysis (also called as Component analysis) is a mathematical technique used to partition total change in output in to its component as output growth due to change in technology and change in the quantity of input use. Solow (1957) developed an approach to evaluate the effects of technical change on output. Bisaliah (1977) extended the framework of decomposition analysis. He showed that, production function can be used to measure change in output due to technical change and due to change in level of input used. Generally, the output decomposition analysis is used to decompose the output by comparing the production function viz; local variety and improved variety, Bt. Cotton and non- Bt. Cotton, rainfed and irrigated crop production, dibbled and transplanted method of cultivation, etc. In present study, there were very limited samples for local variety. Hence, output decomposition analysis is carried out on the basis of adoption levels of farmers. i.e. low adopters and high adopters. Definitely, there was gap in output of low and high technology adopters. So, the technology wise output decomposition analysis of soybean between low and high technology adopters have been carried out and presented as below.

Table 1. Geometric mean levels of inputs used and output produced in soybean production

Sr.No.	Components	High adopters	Low Adopters	Per cent change in input use/Output
1.	Soybean yield (q/ha)	20.00	15.90	25.78
2.	Human labour (man days)	47.6	56.2	-15.30
3.	Bullock labour (pair days)	2.62	4.71	-44.37
4.	Machine labour (hr)	1.07	1.38	-22.46
5.	Manures (q/ha)	1.27	0.7	81.43
6.	Nitrogen (kg/ha)	24.76	20.47	20.96
7.	Phosphorus (kg/ha)	29.42	20.65	42.47
8.	Potassium (kg/ha)	5.24	4.77	9.85

Decomposition of productivity gain in soybean production in Maharashtra

The results of the decomposition analysis for soybean production are presented in the Table 2. The total gain in production due to the shift from 'low adopters' to 'high adopters' was found to be 24.99 per cent, which was mainly contributed due to the difference in the levels of input use. The contribution of technological change to the yield gain was 17.40 per cent, which implies that the output of the soybean production could not be increased with the same levels of inputs used by low adopters. Among the components of technological change, the contribution of neutral technological change in total productivity was estimated to be -6.64 per cent. The negative neutral technologies implied that, there was decrease in efficiency of inputs used by the low adopters, as the farmers were not able to adjust to the requirements of new methods for soybean production. While, the contribution of non-neutral technologies to the yield gain was estimated to be 24.05 per cent. This indicates that, high adopters in place of low adopters would bring an upward shift in the soybean yield. With regard to the difference in the level of input use, manures contributed to 6.57 per cent gain in the soybean production of the total 7.58 per cent of gain due to input use. The increase in the quantities of manures to the farm is the result of the productivity gain through the improvement of soil physical properties compared to chemical fertilizers with high nutrient content in the field. The contribution of chemical fertilizers to the productivity gain was up to 3.15 per cent. The productivity gain from the use of human labour (-1.24 %), bullock labour (-0.17 %) and machine labour (-0.73 %) was found to be negative, indicating the over use of this inputs. The total contribution of the differences in levels of input use to the productivity gain was 7.58 per cent, which indicated that, low adopters can increase the production of soybean to an extent of 7.58 per cent, if the input use levels by these adopters could be increased to the same level of input use levels by high adopters.

various location specific/region specific technologies to practicing farmers and test their implement ability and viability and obtain feedback from the end users and bring about necessary corrections to improve their acceptability and suitability in real farm situation vis-à-vis prevailing traditional farmers practices. Frontline demonstrations are also one of the methodologies to evaluate performance of technology under on farm condition, technology adoption by the participating farmers and its diffusion to non-participating farmers. Large variation in crop yield exists from place to place depending on the environment, soil type and use of cultivation practices, etc. The available agricultural technology does not serve its purpose till it reaches and adopted by its ultimate users, the farmers.

Table 2. Decomposition of productivity gain in soybean production

Sr.No.	Sources of technical change	Percent contribution
A.	Total observed productivity gain	25.78
B.	Productivity gain due to technological change	
	a. Neutral technological change	-6.64
	b. Non–neutral technological change	24.05
	Total productivity gain due to technological change (a+b)	17.40
C.	Productivity gain due to input use	
	a. Human labour	-1.24
	b. Bullock labour	-0.17
	c. Machine labour	-0.73
	d. Manure	6.57
	e. Chemical fertilizers	3.15
	Total productivity gain due to input use (a+b+c+d+e)	7.58
D.	Total estimated productivity gain (B + C)	24.99

Thus it can be inferred that, from the decomposition analysis, that the high adopters were not able to consolidate the technology gain. The yield gain was mainly due to the adjustments made in the level of input used. Hence, the extension agencies should make efforts to train the farmers about the adoption of new soybean production technologies. The decomposition analysis revealed that, the yield gain by the high adopters was mainly due to the application of manures in the field. There was a slight discrepancy between observed and estimated gains in productivity between low adopters and high adopters. This may be attributed to the random term, which among others, accounts for variable management input which could not be included in the model. Such discrepancies of varying degree in decomposition analysis were also encountered in earlier studies Umesh (1987), Basavaraja et al. (2008). However, in the present study, since the discrepancy in question was of a very low order, the results of the decomposition analysis were considered to be satisfactory.

Yield gap analysis

The concept of yield gaps originated from the studies conducted by IRRI in the seventies. The yield gap is the difference between the potential farm yield and the actual average farm yield. The yield gaps are mainly caused by biological, socio-economic, climate and institutional/policy related factors. Different strategies, such as integrated crop management (ICM) practices, timely supply of inputs including credit to farmers, research and extension collaboration to transfer the new technologies are responsible for minimizing yield gaps. Frontline demonstration is the most effective tool for extending useful technologies and their adoption among the target groups. The objectives of frontline demonstration on crops are to demonstrate the superior production potentials of

Technology transfer refers to the spread of new ideas from originating sources to ultimate users. Conducting of Frontline demonstrations on farmer’s field help to identify the problems and potential of that crop in specific area as well as it helps in improving the economic and social status of the farmers. With the objective of knowing the gap between the experimental farm yield and potential farm yield on one hand and actual yield on the sample farms on the other, yield gap in soybean was calculated.

Yield gap analysis for soybean production

According to the officials of the Commissionerate, scientists and technicians of the SAU’s, the potential yield of soybean is different in different agro-climatic zones. However, the discussions with the government officials, scientists SAU”s, district level and village level officials revealed that the yield of soybean can go up to 37 quintals per hectare. Assuming this figure as the potential yield in case of Maharashtra, yield gap was found. The data showed in Table 3 that, the yield of soybean fluctuated successively in different regions of Maharashtra state. It was evident from the table that, potential yield (Y_p) and demonstration plot yield (Y_d) at state level for soybean was worked out to be 37.00 and 28 q/ha, respectively. However, the actual farm yield (Y_a) was worked out to be 20.27 q/ha. There existed 24.32 and 27.60 per cent yield gap- I and II, respectively at the state level. The maximum yield gap-I was observed in Western Maharashtra and Vidarbha (26.32 %) followed by Marathwada (20.00 %) region, while the yield gap-II was maximum in Vidarbha (31.54 %). It is observed that the yield gap-I is not very high and if ideal conditions are provided, it can equalize the experimental yield. It is observed that yield gap-II is very low. More than 75 percent of the land under soybean on sample farms is unirrigated.

Table 3. Regionwise estimated yield gap in soybean in Maharashtra

Sr.No.	Particulars	Y_p (q/ha)	Y_d (q/ha)	Y_a (q/ha)	Gap (%)
A.	Western Maharashtra				
1	Yield gap-I	38.00	28.00	-	10.00 (26.32)
2	Yield gap-II	-	28.00	20.25	7.75 (27.68)
B.	Marathwada				
1	Yield gap-I	35.00	28.00	-	7.00 (20.00)
2	Yield gap-II	-	28.00	21.40	6.6 (23.57)
C.	Vidarbha				
1	Yield gap-I	38.00	28.00	-	10.00 (26.32)
2	Yield gap-II	-	28.00	19.17	8.83 (31.54)
D.	Maharashtra				
1	Yield gap-I	37.00	28.00	-	9.00 (24.32)
2	Yield gap-II	-	28.00	20.27	7.73 (27.60)

Source: 1. Y_p=For Potential yield (GoM, 2013) 2. Y_d= For potential farm yield (Demonstration plot yield) and 3. Ya=Discussions with farmers, various officials, field survey.

It is likely that provision of irrigation to these farms would increase the yield leading to reduction in yield gap. Hence, It can be concludes that, there is a scope for at least doubling the soybean productivity in the different regions of Maharashtra state by appropriate policy development and strengthening execution at grass-root level. Similar findings were also observed by Bhatia et al. (2008), Choudhary and Yadav (2009), Jha et al. (2011) and Swain (2013).

Conclusions

The per hectare estimates of geometric mean levels of soybean output and the level of different inputs used in soybeanproduction were revealed that, the soybean production in high adopters farms was 25.78 per cent more than in low adopter farms. The other input component viz.; human labour, bullock labour and machine labour, etc. were used at lower side than that of low adopters. This was mainly because of that, the use of labours, bullock and machinery were used efficiently by large adopter farms.The decomposition analysis for soybean revealed that, the technological and input use difference between for soybean contributed to form the total productivity difference of 25.78 per cent, whereas, the contribution of technological change to total change in output alone was estimated to be 17.40 per cent. This implies that, with the present level of resource use by the farmers, the returns could be increased by about 17 per cent, if proper technologies adopted thereof.The yield performance of soybean showed that, yield of soybean has fluctuated successively in different regions of Maharashtra state. The maximum yield gap-I was observed in Western Maharashtra and Vidarbha (26.32 %) region while, the yield gap-II was maximum in Vidarbha (31.54 %) region.

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