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An economic assessment of soybean crop production technology

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Abstract
The present study was undertaken with objectives to study the employment, income and expenditure pattern, effects of improved production technology, costs and returns, the resource use productivities, constraints in adoption of improved production technologies, the input use gap and yield gap. Total 954 soybean growers were selected for the study. Extent of adoption of all technologies together was estimated by calculating Technology Adoption Index (TAI).
The technology adoption index was ranged between 44 to 67 per cent for low to high adopters. The crop production alone provided employment to the tune of 35.09 per cent. The wage earning and services or business contributed 4.52 and 29.50 per cent of total employment. The average annual gross income of the soybean sample families at the overall level was ` 4, 96,899 and it ranged from ` 4, 38,227 (low) to ` 5, 55,817 (high). The crop production accounts almost half of the annual expenditure at the overall level. The seed were used at some higher doses (1.92 per cent). This may be because of the fear of poor germination or crop failure.
The added yield was 3.28 Q/ha and 6.77 Q/ha over the low and medium level of adoption. Thus, for producing this extra yield per hectare costs were also increased from ` 6,359.04 to ` 7,319.60. The yield gap was ranged between 41 to 69 and 20 to 59 per cent, respectively. . The variables viz; human labour and potash for soybean were negatively significant indicating that there was an excess use of these inputs and need to curtail up to recommendation level for increasing output. The sample cultivators reported the problems viz; high cost of manure, non-availability of water for irrigation, high cost of, high cost of ploughing etc.

Keywords: Soybean, impact technology, productivity, farm income, constraints

Introduction
Soybean is known as the “golden bean”, “miracle crop” etc., because of its several uses with over 40% proteins and 20% oil. The use of soybean products in the feed and food industry has increased steadily. The world soybean production is currently 219.8 million metric tons out of which India produced 9.3 million metric tons constituting about 4% of the total world production. Out of this production, less than 10% is directly used for human consumption (Gandhi, 2006). The dominant position of soybeans and their products is primarily associated with their high nutritional quality especially with respect to protein and amino acids.
The present utilization pattern of soybean in India indicated that 85 per cent used for oil extraction, 10 per cent for seed and only 5 per cent for food and feed. It occupies an area of 10.84 million ha with productivity of around 1352 kg/ha (2012-13). Among the total oilseed crops, soybean occupied the highest area (3219 thousand ha). In soybean production, Maharashtra stands 2nd among the states.
The Government of India has launched the new scheme, “Integrated Scheme of Oilseeds, Pulses, Oil palm and Maize (ISOPOM)” which provides flexibility to states these implement in the scheme based on a regionally differentiated approach for promoting crop diversification. In order to achieve, the required production level of soybean through higher productivity, in depth analysis of soybean production methods and adoption pattern of technology is necessary. Therefore, the study was undertaken. The major oilseed crop soybean grown in Western Maharashtra was considered for the study with objectives to study the employment, income and expenditure pattern among the different adoption groups, to study the effects of improved soybean production technology on per hectare resource use structure, costs and returns, to study the resource use productivities of major inputs of soybean, to ascertain the constraints in adoption of improved soybean production technologies and to estimate the input use gap and yield gap of soybean. The three stage stratified random sampling design was adopted with tahsil as a primary unit, villages as the secondary unit and the oilseed grower as an ultimate unit of sampling. This study has been carried out in 15 tahsils which were selected on the basis of crop complex approach i.e. the proportionate area under selected soybean crop, from ten

districts of Western Maharashtra. From each selected tahsil, a village (In case of no availability of required sample size, cluster approach was employed) having the highest area underneath soybean was considered for the study.
Total 954 soybean growers were selected for the study.

Technology adoption index (T. A. I.)
Extent of adoption of all technologies together was estimated by calculating Technology Adoption Index (TAI) as per Ranjitkumar's formulae as below,

$$TAI = \frac{1}{K}\left[\frac{A_{X1}}{R_{X1}} + \frac{A_{X2}}{R_{X2}} + - + \ - - + \frac{A_{Xn}}{R_{Xn}}\right]*100$$

Where,
TAI = Technology Adoption Index (%)
K = No. of technology
$A_{X\,n}$ = Actual score of selected technology
$R_{X\,n}$ = Recommended score of selected technology

The selected farmers were grouped as low, medium and high adopters according to the mean and standard deviation of the calculated Technology Adoption Index as follows,
Low adopters = Mean - SD
Medium adopters = Mean - SD to Mean + SD
High adopters = Mean + SD

Functional analysis
I. Resource productivity
The functional analysis was carried out by using Cobb-Douglas type of production function,

$$Y = a\, x_1^{b1}\, x_2^{b2}\, x_3^{b3}\, x_4^{b4}\, x_5^{b5}\, x_6^{b6}\, x_7^{b7}\, x_8^{b8}\, x_9^{b9}\, e^{u}$$

Where,
Y = Output (Q /ha)
X1 = Human labour (Mandays /ha)
X2 = Bullock labour (Pair days /ha.)
X3 = Manures (Q /ha.)
X4 = Nitrogenous fertilizers (kg/ha.)
X5 = Phosphatic fertilizers (kg/ha)
X6 = Potassic fertilizers (kg/ha.)
X7 = Plant protection (kg/ha.)
X8 = No. of irrigations
X9 = Technology Adoption Index (%)
A = Constant
u = Error term.
bi's = Regression coefficients

II. Input use and yield gap
The yield gap was estimated by using the methodology developed by International Rice Research Institute (IRRI), Manila, Philippines. The methodologies for estimation of different types of yield gaps are,

Yield Gap I = YP – Ya

Where,
YP = Potential Farm Yield (Yield realized on demonstration plots)
Ya = Actual Yield (Yield realized on sample farm)

Yield Gap II = Yd – Ya

Where,
Yd = Demonstration yield (Yield realized at research station)
Ya = Actual yield (Yield realized on sample farms)

Results
Distribution of sample cultivators
The selected sample cultivators were grouped as low, medium and high adopters on the basis of estimated Technology Adoption Index (TAI) and shown in Table 1.

Table 1: Distribution of sample cultivators on technology adoption Index.

	Sample cultivators	TAI (%)	Number
Level of adoption	Low	Below 44.07	143 (14.99)
	Medium	44.08 - 66.60	680 (71.28)
	High	Above 66.61	131 (13.73)
	Total	954 (100.00)	954 (100.00)

(Figures in the parentheses indicated percentages to respective total)

The sample cultivators on technology adoption index were grouped as low, medium, high adopters. Total 954 cultivators were under study. The per cent contributed by low adopters was 14.99, medium adopters 71.28 and high adopters 13.73. The technology adoption index was ranged between 44 to 67 per cent for low to high adopters. The medium technology adoption farmers were more among three groups.
Choudhary and Yadav (2009) [3] studied the technology index. Technology index indicates the feasibility of the evolved technology in the farmers' fields. Technology index varied from 28.46 to 53.21 percent in the oilseeds during both the years of the study. The lowest technology index was recorded in soybean crop.

Employment, income and expenditure pattern
The average annual employment of farm families of the sample soybean growers is given in Table 2.
At the overall level, the average annual employment of sample family was found to be 551.21 days. The average annual employment available on their own farm including crop production and livestock activity was to the tune of 50.20 per cent. The crop production alone provided employment to the tune of 35.09 per cent. The wage earning and services or business contributed 4.52 and 29.50 per cent of total employment, respectively. The total per worker annual employment of family worker was 591.30 days, 530.36 days and 615.65 days for low, medium and high adoption groups, respectively. The proportion of employment increased with adoption group except for medium group of adoption.

Table 2: Annual employment of farm families (Days/farm)

Sr. No.	Particulars	Adoption group			
		Low	Medium	High	Overall
A.	**Own farm employment**				
1	Crop production	266.42 (45.06)	179.80 (33.90)	184.46(29.96)	193.43(35.09)
2	Livestock activity	81.39 (13.77)	83.24 (15.70)	85.47(13.88)	83.27(15.11)
3	Sub Total	347.81 (58.82)	263.04 (49.60)	269.93(43.84)	276.70(50.20)
B.	**Off-farm employment**				
4	Wage earnings	24.50 (4.14)	23.19 (4.37)	34.25(5.56)	24.90(4.52)
5	Service/ Business	184.59 (31.22)	145.72(22.47)	226.17(36.74)	162.59 (29.50)
6	Others	34.39 (5.82)	98.41(18.56)	85.30(13.86)	87.02(15.79)
8	Sub Total	243.49 (41.18)	267.32(50.40)	345.72(56.15)	274.51(49.80)
	Total employment	591.30 (100.00)	530.36(100.00)	615.65(100.00)	551.21(100.00)

(Figures in the parentheses are the percentages to the total employment)

Annual employment of male worker

The average annual employment of male workers of the sample soybean growers is given in Table 3.

The average annual employment of a male worker was the highest for low adoption group (476.37 days) followed by high (475.35 days) and medium (382.18 days) with an average of 409.09 days at the overall level. The own farm employment contributed 49.76 per cent of total employment at the overall level. It was the highest for low adoption group (53.35 per cent) followed by medium (50.86 per cent) and high adoption (41.23 per cent). The wage earning, services and other employment contributed 3.89, 39.74, 6.61 per cent and of total employment at the overall level. It was 4.71 per cent, 47.58 per cent and 6.48 per cent for high adoption group, respectively and which contributed together to the tune of 58.77 per cent. The off farm employment was 49.14 per cent and 46.65 per cent for medium and low adoption group, respectively.

Table 3: Annual employment of male worker (Days/farm)

Sr. No.	Particulars	Adoption group			
		Low	Medium	High	Overall
A.	**Own farm employment**				
1	Crop production	200.70(42.13)	139.43(36.48)	139.63(29.37)	148.64(36.33)
2	Livestock activity	53.46(11.22)	54.94(14.38)	56.37(11.86)	54.91(13.42)
3	Sub Total	254.16(53.35)	194.37(50.86)	196.00(41.23)	203.56(49.76)
B.	**Off-farm employment**				
4	Wage earnings	14.43(3.03)	14.98(3.92)	22.40(4.71)	15.92(3.89)
5	Service/ Business	184.59(38.75)	145.72(38.13)	226.17(47.58)	162.59(39.74)
6	Others	23.19(4.87)	27.11(7.09)	30.78(6.48)	27.03(6.61)
8	Sub Total	222.21(46.65)	187.81(49.14)	279.35(58.77)	205.54(50.24)
	Total employment	476.37(100.00)	382.18(100.00)	475.35(100.00)	409.09(100.00)

(Figures in the parentheses are the percentages to the total employment)

Annual employment of a female worker

The average annual employment of female workers of the Sample growers is given in Table 4.

Table 4: Annual employment of female workers (Days/farm)

Sr. No.	Particulars	Adoption group			
		Low	Medium	High	Overall
A.	**Own farm employment**				
1	Crop production	65.72(57.18)	40.37(27.25)	44.83(31.95)	44.78(31.51)
2	Livestock activity	27.94(24.31)	28.30(19.10)	29.10(20.74)	28.36(19.95)
3	Sub Total	93.65(81.49)	68.67(46.34)	73.93(52.69)	73.14(51.46)
B.	**Off-farm employment**				
4	Wage earnings	10.08(8.77)	8.21(5.54)	11.85(8.45)	8.99(6.32)
5	Service/ Business	0.00 (0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
6	Others	11.20(9.75)	71.30(48.12)	54.52(38.86)	59.99(42.21)
8	Sub Total	21.28(18.51)	79.51(53.66)	66.37(73.82)	68.98(54.75)
	Total employment	114.93(100.00)	148.18(100.00)	140.30(100.00)	142.12(100.00)

(Figures in the parentheses are the percentages to the total employment)

The total employment of a female worker was 142.12 days at the overall level. In the total female employment, the share of own farm and off farm employment worked out to 51.46 per cent and 48.54 per cent, respectively. The total employment of a female worker was found the highest for medium (148.18 days) followed by high adoption group (140.30 days) and low (114.93 days). The highest own farm employment was observed for low adoption group (81.49 per cent) followed by high adoption (52.69 per cent) and medium adoption groups (46.34 per cent), respectively. The wage earning (8.77 days) contributed largely off farm employment in the low adoption group of sample households.

Annual income of sample families

The per farm source wise annual gross income of sample farm families was depicted in Table 5.

Table 5: Annual incomes of sample families (`/ farm)

Sr. No.	Particulars	Adoption group			
		Low	Medium	High	Overall
1	Crop production	294891(67.29)	349904(70.28)	374430(67.37)	345025(69.44)
2	Livestock	51378(11.72)	55396(11.13)	71112(12.79)	56952(11.46)
3	Wages	45020(10.27)	19685(3.95)	26358(4.74)	24399(4.91)
4	Service	9098(2.08)	22769(4.57)	39501(7.11)	23018(4.63)
5	Business	11255(2.57)	11010(2.21)	3635(0.65)	10034(2.02)
6	Loan taken	26585(6.07)	39123(7.86)	40781(7.34)	37471(7.54)
7	Total	4,38,227(100.00)	4,97,887(100.00)	5,55,817(100.00)	4,96,899(100.00)

(Figures in the parentheses are the percentages to the respective total)

The average annual gross income of the soybean sample families at the overall level was` 4, 96,899 and it ranged from` 4, 38,227 (low) to ` 5, 55,817 (high). Thus, the average annual income of sample families was directly related with adoption group. The share of income received from crop production was 69.44 (per cent) followed by livestock 11.46 (per cent), loan taken (7.54 per cent), wage earnings (4.91 per cent), service (4.63per cent) and business (2.02 per cent) at the overall level. The income received from crop production was the highest for high adoption group (`3, 74,430) followed by medium (`3, 49,904) and low (`2, 94,891) adoption groups. The income received from livestock production was amounted to ` 56,952 at the overall level and it ranged from ` 51,378 (low) to ` 71,112, (high) adoption groups. The income from wage earning and business was highest in high adoption group.

Annual expenditure pattern of sample farm families

Theper farm average annual expenditure of sample farm families is depicted in Table 6.

The average per family annual expenditure of the sample families was of ` 2, 67,969. The crop production accounts almost half of the annual expenditure at the overall level. The cash expenses include purchased inputs like seed, fertilizer, plant protection chemicals and hired human, bullock, machine charges which together accounted for more than that of expenses for imputed resources (own human, bullock, machine charges, rental value of land).

The livestock activity constitute next important item of expenditure and it was ` 48,944 at the overall level and it was high`65,818 in high adoption group. Theper family expenditure on food consumption incurred was ` 11,465 at the overall level and it ranged from ` 9, 716 (low) to ` 11, 998 (high). The investment in business was ` 766 at the overall level.

Table 6: Annual expenditure pattern of sample farm families (`/ farm)

Sr. No.	Particulars	Adoption group			
		Low	Medium	High	Overall
1	**Crop production**				
	a) Cash expenses	117728(46.11)	118741(44.46)	120120(41.95)	118779(44.33)
	b) Imputed resources	18504(7.25)	19291(7.22)	18802(6.57)	19106(7.13)
2	Livestock activity	48879(19.15)	45707(17.11)	65818(22.98)	48944(18.26)
3	**Family expenditure**				
	a) Food consumption	9716(3.81)	11730(4.39)	11998(4.19)	11465(4.28)
	b) Other expenditure	25431(9.96)	29275(10.96)	25236(8.81)	28144(10.50)
4	Business expenditure	980(0.38)	667(0.25)	1049(0.37)	766(0.29)
5	Loan repayment	25092(9.83)	32110 (12.02)	35377(12.35)	31507(11.76)
6	Miscellaneous expenditure	8967(3.51)	9570(3.58)	7955(2.78)	9258(3.45)
7	Total expenditure	2,55,297(100.00)	2,67,091(100.00)	2,86,354(100.00)	2,67,969 (100.00)

(Figures in the parentheses are the percentages to the respective total)

Impact of improved technology of soybean production

Resource use gap

The information on input use and input gap for technology adoption levels of the soybean is shown through Table 7. It is revealed from the table that at the overall level, there exists an excessive gap (From 47 to 87 per cent) in the use of manures for soybean crop. The seed were used at some higher doses (1.92 per cent). This may be because of the fear of poor germination or crop failure. The use of chemical fertilizers shows that 'K' component were used at higher levels. This is due to the use of mixed fertilizers instead of straight fertilizers by the sample cultivators.

Bill ore *et al*. (2009) [1] studied the assessment of improved production technologies of soybean on production and economic potentials in India. Study revealed that, the highest soybean yield (2705 kg/ha) could be achieved under improved technology. This fact has earlier been reported in the literature stating that the improved package of practices followed the national demonstrations for various crops has shown high yield potentials. The variation in mean yield over the years was more in farmer's practice than improved technology. Thus, the improved technology offers greater sustainability as compared to farmer's practice.

Table 7: Input use and gap for different levels of technology adoption in soybean (Per ha)

Resources	Soybean			
	Adoption group			
	Low	Medium	High	Overall
1. Manure (q)				
Rec.	75	75	75	75
Actual	11.73	9.65	39.23	13.91

% Gap	84.36	87.13	47.69	81.45
2. Seed (Kg)				
Rec.	75	75	75	75
Actual	74.38	76.47	78.31	76.44
% Gap	0.83	-1.96	-4.41	-1.92
3. N (Kg)				
Rec.	75	75	75	75
Actual	66.16	59.00	64.45	60.71
% Gap	11.79	21.33	14.07	19.05
4. P (Kg)				
Rec.	50	50	50	50
Actual	39.19	42.89	53.39	43.81
% Gap	21.62	14.22	-6.78	12.38
5. K (Kg)				
Rec.	0	0	0	0
Actual	17.85	16.71	15.29	16.67
% Gap	-117.85	-116.71	-115.29	-116.67
6. Yield (q)				
Rec.	25	25	25	25
Actual	10.58	13.86	20.63	14.33
% Gap	31.78	44.56	17.48	42.68

Note Rec.-Recommended, A-Actual, G-Gap ("- ve" sign indicates excess than recommended levels)

Costs and returns structure

The information on costs and returns of Soybean is depicted through Table 8.

The per hectare cost, returns and net profit is compared as per the adoption level of the oilseeds technologies. It is revealed from the table that the per hectare yield is increasing as farmers adopt the higher level of oilseed technologies for groundnut. The per hectare yield has increased from 10.58 to 20.63 quintal per hectare over the different level of adoption. The added yield was 3.28 Q/ha and 6.77 Q/ha over the low and medium level of adoption. Thus, for producing this extra yield per hectare costs were also increased from ` 6,359.04 to` 7,319.60 and accordingly, the added returns were also increased from ` 11,671.54 to ` 16,355.26.

Table 8: Cost and returns from soybean (per ha)

Sr. No.	Item	Technology adoption level		
		Low	Medium	High
1	TAI	< 44.07	44.08 - 66.60	66.61 – 97.57
2	Yield	10.58	13.86	20.63
3	Added yield	-	3.28	6.77
4	% increase in yield	-	31.00	48.85
5	Cost C	34436.39	40795.43	48115.03
6	Added cost	-	6359.04	7319.60
7	Cost (Rs./qtls)	3254.86	2943.39	2332.28
8	Unit cost red. (Rs./qtls)	-	311.46	611.11
9	% reduction	-	9.57	20.76
10	Returns	37190.84	48862.38	65217.64
11	Added returns	-	11671.54	16355.26.
12	ICBR ratio	-	1.84	2.23

The ICBR ratio indicates that the high adopter farmers were in profit with 2.23 ICBR ratios and followed by medium adopters with ICBR ratio of 1.84. It clearly indicates that, the farmers should adopt the soybean technologies to the fuller extent for maximizing returns and minimizing per unit cost.

Farkade (2011) [4] studied economic analysis of production and marketing of soybean in Vidarbha region of Maharashtra. Study revealed that, the per hectare gross income received was Rs. 19,650, Rs. 22,228 and Rs. 23,315 in small, medium and large farmers obtained higher gross income followed by small and medium farmers, respectively. The productivity was from 19.20 to 23.34 quintals per hectare. Net farm income was Rs.7372 in small size group and Rs.11, 002 and Rs.12, 419 in medium and large size group. Per hectare profit at cost 'A' was the highest in large (Rs.15, 330) size group followed by medium (Rs.14, 298) and small (Rs. 11,268) farmers. Similar trend was noticed in the case of profit at cost 'B' and cost 'C'. At the overall level, the benefit cost ratio at cost 'C' was 1.89. The ratio was highest in large size group followed by medium and small size groups.

Yield gap in soybean production on farms

The potential yield soybean was 35.00 quintals whereas the demonstration farm yield was 26.00 quintals, respectively. However, for soybean the yield gap was ranged between 41 to 69 and 20 to 59 per cent, respectively.

Table 9: Yield gap in soybean production on farms (Q)

Particulars	Low	Medium	High
Potential Yield	35		
Actual Yield	10.58	13.86	20.63
Yield Gap I	24.42	21.14	14.37

% gap	69.77	60.4	41.06
Demonstration Farm Yield	26		
Actual Yield	10.58	13.86	20.63
Yield Gap II	15.42	12.14	5.37
% gap	59.31	46.69	20.65

Resource use productivity of soybean production

The resource use productivity of soybean production has been Estimated by using Cobb-Douglas type of production function and the results are presented in Table 10.

Table 10: Results of cobb-Douglas production function

Items		**Soybean (N=954)**
Constant	(a)	2.2734
Human labour (Man days/ha.)	X_1	-0.7823***(0.0572)
Bullock labour (Pair days/ha.)	X_2	-0.0065 (0.0152)
Manure (Q/ha)	X_3	0.0081(0.0128)
Fertilizers (Kg. /ha.) N	X_4	0.0503*(0.0305)
P	X_5	-0.0277(0.0272)
K	X_6	-0.0369 ***(0.0134)
Plant protection (`/ha)	X_7	0.0033(0.0071)
Irrigation (no)	X_8	-0.027(0.0618)
Adoption Index (%)	X_9	0.1695*(0.0979)
R^2		0.41

(Figs. in the parentheses indicate the standard error of respective regression coefficient)

***, **, & * indicates the 1, 5, & 10 per cent level of significance

The nine independent variables have jointly explained 41 per cent variation in output for soybean. The variables viz; human labour and potash for soybean were negatively significant indicating that there was an excess use of these inputs and need to curtail up to recommendation level for increasing output.

Chamak *et al.* (1978) [2] studied the resource use efficiency in Punjab agriculture. Cobb- Douglas production function was used. The results showed that medium size farmers, human labour and bullock labour were negative which pointed to its negative marginal productivity. Bullock labour was significant, but bore a negative sign the medium farm have to make use of hired labour and so make lesser use of human labour. It revealed that land, labour and working capital were significant variables explaining charges in output however, bullock labour found to be significant variable adversely affecting the output.

Extent of adoption of technology at different levels of adoption

The technology package for soybean of MPKV, Rahuri were recommended and published for the benefit of farmers of the Western Maharashtra. However, the technology recommended by the University is not adapted to the fuller extent by the soybean growers. In view of this, the extent of adoption of technology for Soybean is presented in Table 11. It is revealed that, 95 per cent farmers were adopted the recommended technology of weeding, ploughing (90 per cent), land use (89 per cent), variety use (81 per cent), seed rate (87 per cent), seed treatment (83 per cent) for Soybean.

Table 11: Extent of adoption of technology on sample farm by oilseed growers (Per cent)

Technologies	**Soybean**			
	Low	**Medium**	**High**	**Overall**
Land use	73.42	91.26	92.11	89.10
Preparatory Tillage				
Ploughing	84.81	90.62	96.05	90.54
Harrowing	35.02	40.20	49.56	40.69
Manure	5.06	12.26	58.90	17.03
Variety use	58.86	82.94	96.05	81.49
Sowing time	2.53	15.88	60.53	19.63
Seed rate	69.22	87.32	104.50	87.12
Seed treatment	81.01	84.33	82.89	83.73
Interculturing				
Thinning	--	2.56	2.63	2.24
Weeding	67.09	95.74	121.05	95.19
Hoeing	25.95	50.05	52.63	47.32
Sowing distance	34.18	84.43	97.37	79.65
Fertilizers				
N	46.44	72.25	137.60	76.94
P	30.96	40.17	74.79	43.22
K	--	--	--	--
No. of Irrigation	13.08	24.34	35.96	24.33
Crop protection	26.58	74.41	86.84	69.87

Constraints in adoption of improved production technology

The data for constraints in technology adoption of soybean is depicted in Table 12.

Table 12: Constraints in adoption of improved production technology

Sr. No.	Constraint	Soybean (N=954)	
		No	%
1	High cost of ploughing	721	75.58
2	High cost of harrowing	57	5.97
3	High cost of manure	845	88.57
4	Non-availability of quality manure	632	66.25
5	High cost of seed	726	76.10
6	Non-availability of seed at proper time	629	65.93
7	Non-availability of human/ bullock for Interculturing	711	74.53
8	Costly Weedicide	49	5.14
9	Non-availability of chemical fertilizers at proper time	624	65.41
10	Non-availability of water	781	81.87
11	Irregular electric supply	384	40.25
12	Plant Protection is costly	108	11.32
13	Non-awareness	225	23.58

It is revealed from the table that, about 88 per cent sample cultivators reported that high cost of manure followed by non-availability of water for irrigation (81 per cent), high cost of seed (76 per cent), high cost of ploughing (75 per cent), non-availability of human/bullock labour for inter-culturing (75 per cent), Non-availability of quality manure (66 per cent), Non-availability of chemical fertilizers at proper time (65 per cent), irregular electric supply (40 per cent) of the selected cultivators.

Kajale and Shroff (2013) [6] studied the problems and prospects of soybean cultivation in Maharashtra. Study revealed that lack of irrigation was found to be the important constraint. Incidence of pests and diseases, high input costs, shortage of human labour, price related risks are observed to be important constraints for all types of farmers as for more than 50 percent of the farmers; these are severe and moderate constraints. Responses relating to the question on oilseeds show that soybean crop is relatively definitely profitable as the index value of the constraint constructed for this regard is only 1.75. Responses also show that this crop is relatively less risky. The index value for this particular economic factor is one of the lowest i.e. 1.61 for all farms. In case of institutional factors, around 30 to 40 percent of the respondents are of the opinion that institutional factors moderately constrain the soybean cultivation. A similar response pattern is observed for postharvest and marketing related questions. As per the responses, economic factors turn out to be important constraints on soybean cultivation.

Conclusions

1. The technology adoption index was ranged between 44 to 67 per cent for low to high adopters. The medium technology adoption farmers were more among three groups.
2. The average annual employment of sample family was found to be 551.21 days. The annual employment of a male worker was the highest for low adoption group 476.37 while annual employment at the overall level was 409.09 days. The total employment of a female worker was 142.12 days at the overall level. The total employment of a female worker was found the highest for medium adoption group (148.18 days)
3. The average annual gross income of the soybean sample families at the overall level was ` 4, 96,899 and it ranged from ` 4, 38,227 (low) to ` 5, 55,817 (high).
4. The average per family annual expenditure of the sample families was of ` 2, 67,969. The crop production accounts almost half of the annual expenditure at the overall level.
5. The seed were used at some higher doses (1.92 per cent) because of the fear of poor germination or crop failure, excess use of Potassic fertilizers was noticed. Whereas, inadequate use of phosphoric fertilizer for soybean.
6. For the high adoption group, crop wise per quintal savings in cost as compared to low adoption group was ` 611 for soybean. This indicated that the adoption of improved crop production technology helps to reduce the cost and increases the returns.
7. The productivity of soybean under study ranged between 10.58 to 20.63 q/ha for soybean of technology adoption groups. Thus there is potential for technology adoption which may help productivity expansion by 3.49 q/ha for soybean by technology adoption groups.
8. The nine independent variables have jointly explained 41 per cent variation in output. The variables viz; human labour and potash for soybean were negatively significant indicating that there was an excess use of these inputs and need to curtail up to recommendation level for increasing output.

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