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Sunflower production technology: An economic analysis

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Abstract
Sunflower (*Helianthus annuus* L.) is an important oilseed crop in India popularly known as "Surajmukhi.". Total 450 Sunflower growers were selected were selected randomly. The per cent contributed by low adopters was 10.30, medium adopters 73.33 and high adopters 16.36. The average annual employment of sunflower sample family was found to be 475.27 days at the overall level. The crop production alone provided employment to the tune of 28.55 per cent. The average annual gross income of the sunflower sample families at the overall level was ` 5, 06,984. The income received from crop production was 63 per cent.
The per cent gap in seed use was 14.60. The use of chemical fertilizers shows that 'P' component in sunflower were used at higher levels. The per hectare yield has increased from 5.8 to 11.88 quintal per hectare over the different level of adoption. The added yield was 2.12 Q/ha and 3.96 Q/ha over the low and medium level of adoption. Thus, for producing this extra yield per hectare costs were also increased from Rs.5,347.20 to Rs.7,140.84 and accordingly, the added returns were also increased from Rs. 9,584.11 to Rs.14,361.92 The yield gap I and II was ranged between 3.12 to 9.20 and 0.12 to 6.2 per cent, respectively.
The nine independent variables have jointly explained the 61 per cent variation in output for sunflower. Human labour (X_1), Phosphorus (X_5) and Technology adoption index (X_9) for sunflower were highly significant at 1 per cent level of significance. The sample cultivators reported the problems viz: non awareness of improved technology, costly plant Protection, non-availability of human/ bullock labor for interculturing etc.

Keywords: sunflower, impact technology, productivity, farm income

Introduction
Oilseed sector occupies a unique position in Indian agriculture. The country is one of the largest producers and exporters of oilseed in the world, 6-7 per cent of world's oilseed production (De, 2011). The production of oilseed during 2007-08 was 25.93 million tones and rose to 27.53 million tones in 2011-12 (MoA, 2013) [6]. When we compared to 53.39 million tones of oilseed domestic demand in 2011-12, the deficit/shortage of oilseed in the country during the same period was almost 26 million tones. This gap is filled up by importing from other nations (De, 2011). The importance of oilseed arises from the fact that it is the chief source for supply of fat to the human beings and oil cake to the domesticated animals. Among the oilseed crops, groundnut, sunflower, safflower, rapeseed-mustard, sesame, niger and soybean are the major ones. India in the mid 1990s had almost attained self-sufficiency in the production of oilseeds to extract vegetable oil, which are essential in the Indian diet (Joshi, 2009; Shenoi, 2003) [3].
Sunflower (*Helianthus annuus* L.) is an important oilseed crop in India popularly known as "Surajmukhi". It occupies an area of 0.75 million ha with productivity of around 720 kg/ha (2012-13). Among the total oilseed crops sunflower occupied 84 thousand ha area. In oilseeds production, Maharashtra stands fourth and third in sunflower production 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 Sunflower through higher productivity, in depth analysis of Sunflower production methods and adoption pattern of technology is necessary. Therefore, the pooled analysis on "Sunflower Production Technology - an economic analysis" was undertaken for three years i.e. 2011-12, 2012-13 and 2013-14. The oilseed crop sunflower grown in Western Maharashtra was considered for the study with the objectives to study the employment and income among the different adoption groups; to study the effects of improved sunflower production technology on per hectare resource use structure, costs and returns; to study the resource use productivities of major inputs of sunflower, to

estimate the input use gap and yield gap of sunflower and to ascertain the constraints in adoption of improved sunflower production technologies.

Materials and Methods

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 was conducted in 15 tahsils, which were selected on the basis of crop complex approach i.e. the proportionate area under selected Sunflower crop, from ten districts of Western Maharashtra. From each selected tahsil, a village (in case of non-availability of required sample size, cluster approach was employed) having the highest area under sunflower was considered for the study.
On the basis of operational holding, Total 165 Sunflower 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 = less than (Mean – SD)
Medium adopters = Mean - SD to Mean + SD
High adopters = greater than (Mean + SD)

Functional analysis
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 (Rs. /ha.)
X8 = No. of irrigations
X9 = Technology Adoption Index (%)
a = Constant
u = Error term.
bi's = Regression coefficients

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 and Discussion
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. The sample cultivators on technology adoption index were grouped as low, medium, high adopters. The per cent contributed by low adopters was 10.30, medium adopters 73.33 and high adopters 16.36. The technology adoption index was ranged between 36 to 65 per cent for low to high adopters. The medium technology adoption farmers were more among three groups.

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

	Sample cultivators	TAI (%)	Number
Level of adoption	Low	Below 36.79	17 (10.30)
	Medium	36.80 - 65.98	121 (73.33)
	High	Above 65.99	27 (16.36)
	Total	165(100.00)	165(100.00)

(Figures in the parentheses indicated percentages to respective total)

Employment and income pattern

The average annual employment of farm families of the sample Sunflower growers is given in Table 2.The average annual employment of sunflower sample family was found to be 475.27 days at the overall level. The average annual employment available on their own farm including crop production and livestock activity was 44.08 per cent. The crop production alone provided employment to the tune of 28.55 per cent. The wage earning and services or business accounted for 20.88 and 26.08 per cent of total employment, respectively. The total annual employment of family worker was 359.63 days, 435.76 days and 431.94 days for low, medium and high adoption groups, respectively.

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	107.48 (29.89)	140.35 (32.21)	116.74 (27.03)	135.71(28.55)
2	Livestock activity	48.05 (13.36)	77.65 (17.82)	65.48 (15.06)	73.77(15.52)
3	Sub Total	155.53 (43.25)	218.00 (50.03)	182.22 (42.19)	209.4844.08)

B.	Off-farm employment				
4	Wage earnings	101.53 (28.23)	90.91 (20.86)	120.01 (27.78)	99.23 (20.88)
5	Service/ Business	63.30 (17.60)	84.92 (19.49)	87.89 (20.35)	123.97 (26.08)
6	Others	39.27 (10.92)	41.93 (9.62)	41.83 (9.68)	42.59(8.96)
8	Sub Total	204.11(56.75)	217.76 (49.97)	249.72 (57.81)	265.79 (55.92)
	Total employment	359.63 (100.00)	435.76(100.00)	431.94 (100.00)	475.27(100.00)

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

Annual income of sample families

The per farm source wise annual gross income of sample farm families was depicted in Table 3. The average annual gross income of the sunflower sample families at the overall level was `5, 06,984 and it ranged from ` 3, 53,227 (low) to ` 5, 81, 604 (high). The share of income received from crop production was 63.55 per cent followed by livestock 9.43 per cent, wage earnings (9.25 per cent), loan taken (9.23 per cent), business (4.91 per cent) and service (3.64 per cent) at the overall level.

Table 3: Annual incomes of sample families (`/farm)

Sr. No.	Particulars	Adoption group			
		Low	Medium	High	Overall
1	Crop production	245618 (69.53)	323955 (63.36)	362478 (62.32)	322188 (63.55)
2	Livestock	22046 (6.24)	49349 (9.65)	57158 (9.83)	47814 (9.43)
3	Wages	36254 (10.26)	46944 (9.18)	53263 (9.16)	46877 (9.25)
4	Service	0 (0.00)	20095 (3.93)	22667 (3.90)	18445 (3.64)
5	Business	30144 (8.53)	24738 (4.84)	22149 (3.81)	24871 (4.91)
6	Loan taken	19214 (5.44)	46212 (9.04)	63889 (10.98)	46789 (9.23)
7	Total	353277 (100.00)	511294 (100.00)	581604 (100.00)	506984 (100.00)

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

The income received from crop production was the highest for high adoption group (` 3, 62,478) followed by medium (` 3, 23,955) and low (` 2, 45,618) adoption groups. The income received from livestock production was amounted to ` 47,814 at the overall level and it ranged from ` 22,046 (low) to ` 57,158 (high) adoption groups. The income from wage earning and business was the highest (10.26 and 8.53%) in low adoption group and for service it was in medium adoption group. The access of farmers to credit shown range from ` 19,214 (low) to ` 63,889 (high) with an average of ` 46,789 at the overall level. So, it was concluded that total farm income increased among the adoption groups after the introduction of crop production technology.

Impact of improved technology of Sunflower production
Resource use gap

The information on input use and input gap for technology adoption levels of the Sunflower is shown through Table 4.

It is revealed from the table that, at the overall level, there exists an excessive gap (from 8 to 83 per cent) in the use of manures. The per cent gap in seed use was 14.60 at the overall level. The use of chemical fertilizers shows that 'P' component in sunflower were used at higher levels. This is due to the use of mixed fertilizers instead of straight fertilizers by the sample cultivators.

Similar results were found by Jadhav *et al.* (1993) [2]. They studied the resource productivity in summer groundnut production in Sindhudurg district of Maharashtra in 1989-90. They found that there was excessive use of inputs and there was need to organize the allocation of resources.

Table 4: Input use and gap for different levels of technology adoption in Sunflower (Per ha)

Resources	Sunflower			
	Adoption group			
	Low	Medium	High	Overall
1. Manure (q)				
Recommanded	25	25	25	25
Actual	4.2	6.08	22.81	8.55
% Gap	83.20	75.68	8.76	65.80
2. Seed (Kg)				
Rec.	10	10	10	10
Actual	8.38	8.37	9.38	8.54
% Gap	16.20	16.30	6.20	14.60
3. N (Kg)				
Rec.	50	50	50	50
Actual	44	37.92	53.82	41.22
% Gap	12.00	24.16	-7.64	17.56
4. P (Kg)				
Rec.	25	25	25	25
Actual	34.53	33.81	51.47	36.74
% Gap	-38.12	-35.24	-105.88	-46.96
5. K (Kg)				
Rec.	25	25	25	25
Actual	10.13	17.02	22.00	16.99
% Gap	59.48	31.92	12.00	32.04

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 Sunflower is depicted through Table 5.

Table 5: Cost and returns from sunflower (per ha)

Sr. No.	Item	Technology Adoption Level		
		Low	Medium	High
1	Yield	5.8	7.92	11.88
2	Added yield	-	2.12	3.96
3	% increase in yield	-	36.55	50.00
4	Cost C	31588.22	36935.42	44076.26
5	Added cost	-	5347.20	7140.84
6	Cost (Rs./qtls)	5446.25	4663.56	3710.12
7	Unit cost red. (Rs./qtls)	-	782.68	953.44
8	% reduction	-	14.37	20.44
9	Returns	35939.98	45524.09	59886.01
10	Added returns	-	9584.11	14361.92
11	ICBR ratio	-	1.79	2.01

The per hectare cost, returns and net profit is compared as per the adoption level of the Sunflower technologies. It is revealed from the Table 6, the per hectare yield is increasing as farmers adopt the higher level of sunflower technologies. The per hectare yield has increased from 5.8 to 11.88 quintal per hectare over the different level of adoption. The added yield was 2.12 Q/ha and 3.96 Q/ha over the low and medium level of adoption. Thus, for producing this extra yield per hectare costs were also increased from Rs. 5,347.20 to Rs.7,140.84 and accordingly, the added returns were also increased from Rs. 9,584.11 to Rs.14,361.92. The similar results was obtained by Singha *et al.*, (2014) [4].

The ICBR ratio indicates that the high adopter farmers were in profit with 2.01 ICBR ratios and followed by medium adopters with ICBR ratio of 1.79. It clearly indicates that, the farmers should adopt the sunflower technologies to the fuller extent for maximizing returns and minimizing per unit cost.

Kerur *et al*. (1997) [5] studied the economics of sunflower production in Northern Karnataka, per hectare cost of production of sunflower was ` 5652.55, ` 5693.11 and ` 5587.73 for small, medium and large farmers, respectively. The average yield obtained for the overall sample was 8.99 quintal per hectare. The benefit: cost ratio was found to be 1.88; indicating sunflower production was a profitable enterprise.

Sreeramalu and Chetty (1973) [12] studied the performance of sunflower and its economics of cultivation in Anantpur district of Andhra Pradesh. The authors found that sunflower cultivation fetched a net profit of Rs. 870 per hectare. Cost of cultivation of sunflower was Rs. 500 per hectare.

Yield gap in Sunflower production

The potential yield was 15.00 quintals whereas the demonstration farm yield was 12.00 quintals, respectively. Yield gap-l referred to the difference between the potential yield and the actual yield and the difference between demonstration farm yield and the actual yield on the respective farms was referred to as yield gap-II. The yield gap I and II was ranged between 3.12 to 9.20 and 0.12 to 6.2 per cent, respectively. The similar results were found by S. M. Patil and L B. Kunnal, 1997 [10].

Table 6: Yield gap in Sunflower production on farms (Q)

Particulars	Low	Medium	High
Potential Yield	15		
Actual Yield	5.8	7.92	11.88
Yield Gap I	9.2	7.08	3.12
% gap	61.33	47.2	20.8
Demonstration Farm Yield	**12**		
Actual Yield	5.8	7.92	11.88
Yield Gap II	6.2	4.08	0.12
% gap	51.67	34	1

Resource use productivity of Sunflower production

The resource use productivity of Sunflower production has been estimated by using Cobb-Douglas type of production function and the results are presented in Table 7.

The nine independent variables have jointly explained the 61 per cent variation in output for sunflower. Human labour (X_1), Phosphorus (X_5) and technology adoption index (X_9) for sunflower were highly significant at 1 per cent level of significance indicating that these are the important variables for which the output is responsive.

Table 7: Results of Cobb-Douglas production function

Items	Sunflower (N=165)
Constant (a)	0.9741
Human labour (Man days/ha.) X_1	0.2860*** (0.0586)
Bullock labour (Pair days/ha.) X_2	-0.0454 (0.0297)
Manure (Q/ha) X_3	0.0345** (0.0141)
Fertilizers (Kg./ha.) N (X_4)	0.0141 (0.0417)
P (X_5)	0.1152*** (0.0407)
K (X_6)	0.01 (0.0171)
Plant protection (`/ha) X_7	0.0240 (0.0149)
Irrigation (no) X_8	-0.0743 (0.0525)
Adoption Index (%) X_9	0.359*** (0.0957)
R^2	0.61

(Figs. in the parentheses indicate the standard error of respective regression coefficient) ***, **, & * indicates the 1, 5, & 10 per cent level of significance

Constraints in adoption of improved Production technology

The data for constraints in technology adoption of sunflower is depicted in Table 8. It is revealed from the table that above 80 per cent of the sample cultivators reported the Non awareness of improved technology, 75 per cent cultivators reported that Plant Protection is costly, 70 per cent cultivators reported that Non availability of human/ bullock labor for interculturing, 64.24 per cent cultivators reported that Non availability of quality manure. High cost of ploughing and manure, non-availability of water for irrigation, irregular electric supply, high cost of seed and plant protection measures, etc. problems were reported by the sample cultivators.

Table 8: Constraints in adoption of improved production technology

Sr. No.	Constraint	Sunflower (N=165)	Per cent
1	High cost of ploughing	47	28.48
2	High cost of harrowing	61	36.97
3	High cost of manure	81	49.09
4	Non availability of quality manure	106	64.24
5	High cost of seed	92	55.76
6	Non availability of seed at proper time	63	38.18
7	Non availability of human/ bullock for interculturing	116	70.30
8	Costly Weedicide	95	57.58
9	High cost of chemical fertilizers	95	57.58
10	Non availability of chemical fertilizers at proper time	64	38.79
11	Non availability of water	73	44.24
12	Irregular electric supply	91	55.15
13	Plant Protection is costly	124	75.15
14	Plant Protection : Non awareness	138	83.64

Pandey *et al*. (1993) [9] studied the productivity constraints of sunflower in Haryana. The main reasons they have given for the existence of sustainable yield gap between the progressive farmers were inadequate and imbalanced use of fertilizers, inadequate irrigation facilities, high infestation of weed, non availability of crucial inputs ie; seed, fertilizers, plant protection chemicals and standard quality on time in rural market at reasonable prices. Non availability of high yielding varieties of oilseeds being also tolerant to common diseases, pest, drought condition.

Conclusions

1. Input use increased with the adoption level of technology and the larger increase was observed under higher adoption group.
2. There was excess use of phosphoric fertilizer for sunflower crop.
3. For the high adoption group, cropwise per quintal savings in cost as compared to low adoption group were ` 953. This indicated that the adoption of improved crop production technology helps to reduce the cost and increases the returns.
4. The productivity of sunflower ranged between 5.80 to 11.88 q/ha for technology adoption groups. Thus there is potential for technology adoption which may help productivity expansion by 1.84 q/ha for sunflower, by technology adoption groups.
5. The nine independent variables considered for functional analysis explained 61 per cent variation in production of sunflower. The variables viz; human labour (X_1), Phosphorus (X_5) and technology adoption index (X_9) were highly significant at 1 per cent level of significance indicating that these are the important variables for which the output is responsive.

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