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Temporal variation in input-output prices and cost of cultivation of soybean in Vidarbha

S.S. THAKARE and N.V. SHENDE

Department of Agricultural Economics and Statistics, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola - 444 104, Maharashtra, India; E-mail: drsandipthakare@gmail.com
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ABSTRACT

A study carried out on the temporal variation in input, output prices and cost of cultivation of soybean in Vidarbha region of Maharashtra state in India during 1999-2000 to 2008-09 revealed that like other inputs, output price of soybean increased by 8.17% per annum. The output-input price parity was decreased during year 1999-2000 to 2000-01, thereby indicating unfavourable trade for soybean growers. However, the trade was favourable after this period. With regards to cost of soybean cultivation per hectare, it increased from ₹ 10,399 to ₹ 17,397 indicating 1.67 times increase during the study period. Due to increase in the manure cost, its use was slightly decreased. However, the use of major critical input like seed was increased from 75.92 to 87.09 kg/ha due to changes in prices of seed. The average cost of production per tonne also varied from ₹ 8,608 (with an average yield of 1579 kg/ha) in 2003-04 to ₹ 15049 (with an average yield of 1156 kg/ha) in 2008-09. This clearly indicated that technological breakthrough in soybean cultivation had not compensated inflation as it was associated without yield increase. Thus, per unit cost of output did not decline over time. Similarly, the gross income from soybean at current prices increased @ 10.76% per annum between 1999-2000 to 2008-09 and might be attributed to both increase in output price as well as increase in yield of seed/by product. However, the rate of increase in cost of cultivation per hectare at current prices was 6.59 per cent. This resulted in an improvement in the net income per hectare of soybean crop over the years. This was further reflected by output-cost ratio, which increased from 0.876 in 1999-2000 to 1.138 in 2008-09. Thus, soybean cultivation became remunerative after 2004-05 in Vidarbha region of Maharasthra, India.

Key words: Growth, Parity Index, Soybean, Temporal variation

Soybean has emerged very recently as an oilseed crop in the cropping pattern of Vidarbha region of Maharashtra state. Although, it is cultivated on a large scale in the neighbouring state of M.P., yet it is new for the state of Maharashtra. The area under other oilseed crops, like groundnut and safflower has decreased over the period in recent years in the state due to their low productivity. However, with increase in population and rise in standard of living, the demand for edible oil has been steadily rising (at 6-7% per year) over the years (Reddy 2009, Reddy *et al.* 2012, Reddy *et al.* 2011).

Soybean was introduced in Vidarbha (M.H.) during the nineties. The area and production has shown a continuously increasing trend during the last decade. The acreage of soybean has increased from 0.035 m ha in 1984-85 to 3.02 m ha during 2009-10 while its production has increased from 0.012 m tonnes to 2.19 million tonnes during the same period. The average yield of soybean realized in Maharashtra is around 1100 kg/ha as against the productivity potential of about 3000-3500 kg/ha. Thus, there is ample scope for its productivity increase so as to make the commodity viable and remunerative. The major soybean growing region in Maharashtra is Vidarbha. The area under oilseeds in Vidarbha region is 1.88 m hectares with average productivity of 1230 kg/ha in 2009-10 and the major soybean growing districts includes Nagpur, Wardha, Amravati, Yavatmal, Akola, Washim and Buldanar.

Transformation of agriculture from subsistence to profitable farm business is a techno-organizational process, the success of which largely depends on the relative prices of various inputs and outputs. Therefore, it would be one of areas of interest to examine the variation in prices of inputs and outputs and cost of cultivation of soybean in Vidarbha region of Maharashtra.

MATERIALS AND METHODS

Collection of data: The Agricultural Prices and Costs (APC) scheme under the guidance of Government of Maharashtra provides valuable data about Agriculture in Maharashtra. The present study used cross sectional cum time series data of Vidarbha region for soybean for a decade *i.e.*, from 1999-2000 to 2008-09. Every year 100 farmers were selected purposively for the present study except 82 farmers in 1999-2000 due to unavailability of data. The scheme was involved in the collection of representative data on input use and yield and estimation of cost of cultivation of principle crops grown in the region. Data was collected every year and for all the enterprises. Although the sample for particular year was selected for a specified principle crop, yet the data was collected for all the crops grown on the sample holdings.

Index of input prices: To study the temporal variation in input and output prices and cost of cultivation, the simple tabular analysis was carried out by using standard cost concept. The input price indices are composite indices of prices of individual items of inputs. The indices were constructed using the cost

of cultivation data for the period of last ten years with average of first triennium ending as the base year. First, the price indices of inputs of seed, labour, bullock labour, fertilizer, farm yard manure, capital, pesticide and depreciation on implements were constructed.

The composite indices of input prices for soybean crop was constructed as

$$\text{Index of Input Price} = \sum_{i=1}^{9} S_i \left(\frac{P_{it}}{P_{io}} \right)$$

Where,

Si = average share of i^{th} input in total input cost

P_{it}/P_{io} = The price index of i^{th} input in t^{th} year using average of first triennium as the base year, i=1stands for Human wage index, i=2 Bullock wage index, i=3 Fertilizer price index, i=4 FYM price index, i=5 seed price index, i=6 Interest rate index, i=7 Pesticide expenditure index, i=8 Depreciation charges index and i=9 Rental value of land index.

Parity index = 100 (Output price index/Input price index)

Changes in input and output prices and cost of cultivation: The data were subjected to tabular analysis to study the changes in input and product prices, cost and returns for soybean. Simple tabular analysis has been used to analyze the temporal variation in the cost of cultivation of soybean. Cost structure of soybean was analyzed by working out the share of each item of cost in the total cost of cultivation. The changes in the structure of cost of cultivation of soybean were assessed by comparing the cost structure of soybean during the base years (*i.e.* 1999-2000 to 2001-02) with that of early years. The share of total temporal change as assignable to individual cost components has also been ascertained.

The cost of production of the seed yield on per quintal basis has been worked out after the apportionment of total cost of cultivation between the main product and the by-product in proportionate to their contribution to the gross value of output. The cost of production per quintal is obtained by dividing the cost of cultivation attributable to the main product by the grain yield on unit area basis. The compound growth rate of values between the initial year and the later year has also been worked out by using formula.

$$Y = ab^t$$

Where, Y= quantity/prices of inputs / yield / prices of output/value of output/cost of production, a = intercept, b = regression coefficient and t = time variable

From the estimated function, the compound growth rate as worked out by CGR(r) = [Antilog (log b) - 1] x 100, Where, r = Compound growth rate

RESULTS AND DISCUSSION

The present study was conducted in Vidarbha region of Maharashtra state and the temporal variation in input and output prices and cost of cultivation was estimated for soybean crop.

Temporal variation in input and output prices and cost of cultivation

The compound growth rates (CGR) of input and output prices of soybean in Vidarbha revealed that the prices of all inputs showed an increasing trend during 1999-2000 to 2008-09 (Table 1). The CGR at current prices of input prices for soybean were highest for FYM (11.18% per annum) followed by prices of human wage rate (7.56% per annum). Per cent growth rate in seed and fertilizer prices were observed to be 7.11 and 3.80 per cent per annum, respectively. The output prices increased at an annual compound rate of 8.17% per annum for soybean during the period under study. Shende and Shinde (2010) reported that output price for soybean increased at an annual compound growth rate of 9.82% per annum in assured rainfall zone (Zone VII) of Vidarbha region.

Table 1. CGR of input and output prices of soybean (1999-2000 to 2008-09)

Item	CGR (% at current prices)	CGR (% at constant prices)
1) Input Prices		
i) Wage rate	7.56***	2.07**
ii) Bullock labour price	3.17***	-2.10**
iii) FYM price	11.18***	5.50
iv) Fertilizer price	3.80*	-1.50
v) Seed price	7.11**	1.64
Aggregate Input Price Index	6.78***	6.78***
2) Output Price	8.17***	2.64**

***, **,*Significant at P = 0.05, P = 0.05 and P = 0.10 respectively

The study also showed that the human wage rate on an average basis at constant prices had increased at an annual rate of 2.07% per annum while bullock wage rate showed the declined trend. The output price for soybean at constant prices had increased at an annual rate of 2.64 per cent per annum during the period 1999-00 to 2008-09.

Parity between prices received for products and prices paid for inputs: Parity prices for farm products are those prices which would give the same purchasing power to the producer as prevailed in the base year. In order to examine the parity between the prices received for output and prices paid for agricultural inputs, parity indices were computed by deflating output price indices by the input price indices.

Parity between output price index and input price index for soybean: Table 2 represents input-output price indices for soybean. It is evident from the Table that between 1999-2000 to 2008-09, the input price index for soybean increased by 69%, while the increase in output price was 97%. Shende and Shinde (2010) also reported that during 1997-98 to 2007-08,

the input price index for soybean increased by 29%, while the increase in output price was 87%.

Table 2. Parity between output and input price index for soybean

Year	Input price Index	Output price Index	Parity Index
1999-2k	91.91	89.25	97.10
2000-01	104.56	104.18	99.64
2001-02	103.80	106.56	102.66
2002-03	110.20	138.92	126.06
2003-04	131.51	141.60	107.67
2004-05	128.05	143.09	111.74
2005-06	119.88	127.58	106.42
2006-07	146.09	148.38	101.57
2007-08	169.97	195.20	114.85
2008-09	169.12	197.61	116.85
Triennium 2008-09	111.13	197.61	177.83

(Base year- average of triennium ending – 1999-2000 to 2001-02)

Further, the output-input price parity were decreased during 1999-2000 to 2000-01, indicating the period was unfavourable for soybean growers as the output price were lower than input price. However, the term of trade was favourable for the soybean growers afterwards.

Changes in cost of cultivation of soybean: The results indicated the changes in the cost of cultivation of soybean in Vidarbha (Table 3). Per hectare cost of cultivation of soybean increased from ₹ 10399.41 in base year (triennium average 1999-00 to 2001-02) to ₹ 17397.13 in 2008-09 showing an increase of 1.67 times during the period of study. The increase in total cost was attributed to the cost of items such as hired human labour, family labour, bullock labour, machine labour, seed, fertilizer, farm yard manure, insecticide, incidental charges, rental value of owned land and interest on working capital while the share of interest on fixed capital and value of depreciation were declined. The highest share in total cost was due to seed, rental value of land, hired human labour and machine labour.

Out of total increase of ₹ 6997.72 in the cost of cultivation of soybean per hectare, 83.91% was contributed by the items of operational cost while the remaining 16.09% by fixed cost. Among the operational items, the share of seed, hired human labour and machine labour accounted for 23.48, 20.02 and 14.33% respectively, of the increase in total cost. The share of family labour, bullock labour, incidental charges and insecticide were 4.75, 4.72, 4.71 and 2.04 per cent, respectively, while the share of manure and fertilizer were 2.28 and 1.37 per cent, respectively. The share of rental value of own land accounted for 21.00 per cent of the increase in total cost. The relative shares of different inputs in the change of cost of cultivation of soybean during base year (*i.e.*, 1999-2000 to 2001-02) and 2008-09 indicated that the share of items of operational cost in the total cost of cultivation was 74.86% in 2008-09 which was higher than that in 1999-2000 (Table 3). But within the operational cost, the share of bullock labour, fertilizer and family labour were decreased while that of seed, machine labour, insecticide, manure and incidental charges for soybean were increased.

The extent of changes in physical inputs (and prices), physical output (and prices) along with gross return from soybean over time indicated that the quantity of manure had slightly decreased due to increase in the cost of manure (Table 4). The use of seed has increased from 75.92 kg/ha in base year to 87.09 kg/ha in 2008-09 due to changes in seed prices. The positive change in seed cost is due to marginal increase in physical seed rate and large increase in the prices of seed over time. Similarly, the change in cost of human labour for soybean is due to physical quantity of human labour used for soybean as well as its prices over the years.

The gross return for soybean recorded an increase of 107.95% during the period of study due to the increase in the main and by-product of soybean as well as (higher) increase in their prices over the years. The minimum support price for soybean has been increased from ₹ 8200 in 1999-00 to ₹ 13700 in 2008-09 which recorded an increase of 4.47% per annum during 1999-00 to 2008-09. Similarly, on an average basis, soybean growers got ₹ 7297.1 per tonne in 1999-00 which varied to ₹ 16155.5 in 2008-09.The cost of production of soybean per tonne also increased from ₹ 9798.6 in 1999-00 to ₹ 15045.4 in 2008-09 resulting in 53.55% in the cost of production during the period study.

In terms of annual growth rate of the estimated parameter of soybean during the period, the cost of production of soybean increased by 4.25% while the gross return on unit area basis increased by 10.76%. The minimum support prices increased by 4.47% during the period which amounted to a total of 67.07%. Shende and Shinde (2010) also reported that gross income from soybean increased at an annual rate of 9.83% in Zone VII of Vidarbha region.

Changes in costs: The cost of production per unit of output depends on the per hectare cost of cultivation and yield. For computing the cost of production at constant factor prices, the unit cost of production at current prices was deflated by an input price index series taking initial triennium ending average as the base year.

Changes in cost of soybean: The cost of production at current and constant prices for soybean is presented in Table 5. The Table revealed that, the increase in yield from 1999-2000 to 2003-04 and from 2005-06 to 2007-08 resulted in substantial fall in the cost per unit of output of soybean at constant prices. Again in 2004-05, a fall in yield per hectare brought about a further sharp escalation in per unit cost of output.

The examination of cost of production at constant price did not indicate any clear trend while the remaining variation in unit cost could be explained in terms of yield fluctuation over the year. It was further observed that any improvement in the yield was followed by lowering down the cost of

Table 3. Changes in cost of cultivation of soybean

Sr. No.	Particulars	Cost of cultivation				Change		Share of total change (%)
		1999-2000 to 2001-02 (base year)		2008-09				
		₹/ha	%	₹/ha	%	₹/ha	%	
A)	Operational costs							
	Hired human labour	1622.13	15.60	3023.02	17.38	1400.89	86.36	20.02
	Family labour	728.83	7.01	1061.32	6.10	332.49	45.62	4.75
	Bullock labour	1358.90	13.07	1689.21	9.71	330.31	24.31	4.72
	Machine labour	766.07	7.37	1769.02	10.17	1002.95	130.92	14.33
	Seed	1156.79	11.12	2799.57	16.09	1642.78	142.01	23.48
	FYM	153.14	1.47	312.64	1.80	159.50	104.15	2.28
	Fertilizer	751.28	7.22	846.94	4.87	95.66	12.73	1.37
	Insecticides	29.47	0.28	359.40	2.07	329.93	1119.55	4.71
	Incidental charges	89.64	0.86	232.72	1.34	143.08	159.61	2.05
	Repairs	83.19	0.80	247.13	1.42	163.94	197.07	2.34
	Interest on working capital	412.40	3.97	682.67	3.91	270.27	65.54	3.86
	Sub-total (A)	7151.84	68.77	13023.64	74.86	5871.80	82.10	83.91
B)	Fixed costs							
	Land revenue and taxes	21.74	0.21	22.62	0.13	0.88	4.03	0.05
	Depreciation	469.22	4.51	319.78	1.84	-149.44	-31.85	-2.17
	Rental value of Land	1808.11	17.39	3277.82	18.84	1469.71	81.28	21.00
	Interest on fixed capital	948.50	9.12	753.27	4.33	-195.23	-20.58	-2.79
	Sub-total (B)	3247.57	31.23	4373.49	25.14	1125.92	34.67	16.09
C)	(Total cost) Cost C (A+B)	10399.41	100.00	17397.13	100.00	6997.72	67.29	100.00

Table 4. The extent of changes in physical inputs, input prices, physical output, output prices and gross return for soybean

Sr. No.	Particulars	1999-00 to 01-02 (base year)	2008-09 (current year)	Change in 2008-09 over base year (%)	Growth rate per annum (%)
A) Quantity of inputs					
1	Seed (kg/ha)	75.92	87.09	14.71	1.20**
2	Fertilizer (kg/ha)	54.20	54.59	0.72	2.52
3	Manure (q/ha)#	4.35	4.29	-1.38	4.09
4	Human labour (hr/ha)	538.04	560.45	4.17	1.77*
5	Bullock labour (hr/ha)	88.17	76.34	-13.42	-0.67
B) Prices of inputs					
1	Seed (₹/kg)	15.24	32.15	110.96	5.88**
2	Fertilizer (₹/kg)	13.86	15.51	11.90	1.25**
3	Manure (₹/q)	35.19	72.85	107.02	6.81***
4	Human labour (₹/hr)	4.37	7.29	66.82	5.69***
5	Bullock labour (₹/hr)	15.41	22.13	43.61	3.87***
C) Yield (q/ha)					
1	Main product	11.13	11.56	3.86	2.39
2	By-product	5.05	6.68	32.28	1.09
D) Price of output (₹/q)					
1	Main product	817.56	1615.55	97.61	8.17***
2	By-product	81.60	171.33	109.96	8.76***
E) Value of output (₹/ha)					
1	Main product	9112.1	18657.84	104.76	10.76***
2	By-product	410.42	1144.78	178.93	9.94**
3	Gross return	9522.52	19802.26	107.95	10.76***
F) Cost of production (₹/q)		979.86	1504.94	53.55	4.25*
G) Minimum Support Price		820	1370	67.07	4.47***

***, **, *Significant at P = 0.01, P = 0.05 and P = 0.10 respectively, # 1q=100 kg

production per tonne. The average cost of production per tonne varied from ₹ 8598.3 (with an average yield of 1579 kg/ha) in the year 2003-04 to ₹ 15049.4 (with an average yield 1156 kg/ha) in the year 2008-09. This clearly indicated that technological breakthrough in the cultivation of soybean could not compensate the inflation. Therefore, per unit cost of output did not decline over time. Thus, it is hypothesized that the improvement in productivity of crops the production function should shift upward with declining cost of production at constant prices. As the cost of production did not decline in the study, it could be inferred that the technological development in soybean could not shown its impact in reducing the cost of production in Vidarbha.

Table 5. Cost of production of soybean

Year	Cost/100 kg at current price (₹)	Input price index	Cost/100 kg at constant price (₹)	Yield per hectare (kg/ha)	MSP at constant prices
1999-00	838.64	91.91	912.46	1113	800.00
2000-01	1017.49	104.56	973.11	1077	779.00
2001-02	926.86	103.80	892.93	1177	781.20
2002-03	951.74	110.20	863.65	1209	739.20
2003-04	859.83	131.51	653.82	1579	708.00
2004-05	1355.87	128.05	1058.86	990	731.50
2005-06	1063.01	119.88	886.73	1205	706.70
2006-07	976.87	146.09	668.68	1494	691.20
2007-08	1100.56	169.97	647.50	1565	637.00
2008-09	1504.94	169.12	889.87	1156	863.10
CGR (%)	4.09**	-	-2.51	-	-0.87

***, **, *Significant at P = 0.01, P = 0.05 and P = 0.10 respectively

Changes in return

Change in cost and return from soybean: The study revealed that the gross income at current prices from soybean increased at an annual rate of 10.76% during 1999-00 to 2008-09 (Table 6). The increased in gross income was attributed to both increase in output price as well as increase in yield of main product and by product. However, the rate of increase in cost of cultivation per hectare was 6.59%. This resulted in an improvement in the net income per hectare of soybean over the year which was further reflected by output-cost ratio that increased from 0.876 in 1999-2000 to 1.138 in 2008-09.

Table 6. Change in cost and returns from soybean ₹

Year	Gross income/ha (at current prices)	Cost/ha (at current prices)	Net income/ha	Output-cost ratio
1999-2k	8178.47	9334.06	-1155.59	0.876
2000-01	9617.83	10957.48	-1339.65	0.878
2001-02	10771.26	10906.66	-135.40	0.988
2002-03	14336.62	11506.85	2829.77	1.246
2003-04	19057.40	13578.85	5478.55	1.403
2004-05	12034.51	13423.95	-1389.44	0.896
2005-06	13106.91	12807.00	299.91	1.023
2006-07	18763.95	14590.00	4173.95	1.286
2007-08	25587.84	17219.39	8368.46	1.486
2008-09	19802.62	17397.13	2405.49	1.138
CGR (%)	10.76***	6.59***	-	-

***, **, *Significant at P = 0.01, P = 0.05 and P = 0.10 respectively

However, from base year to 2004-05, the output-cost ratio was not very impressive mainly due to low productivity per unit area while during 2007-08, the output-cost ratio (1.486) was increased. The input price index for soybean crop also increased at an annual CGR of 6.78% while the output price index increased at 7.07%.

Thus, it was inferred from the above study that soybean cultivation which was unprofitable during 1999-2000 to 2004-05 had become remunerative afterwards in Vidarbha region of Maharashtra, India.

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