

**RESEARCH NOTE**

---

## **Total Factor Productivity of Livestock Sector in Gujarat: Evidence of Technological Changes and Sustainable Growth of Livestock Sector**

**Pushpa Yadav\***, **B.S. Chandel\*** and **Punit Agarwal†**

ABSTRACT

In this study, the total factor productivity (TFP) performance of livestock sector in Gujarat has been estimated for the period of 1970-71 to 2014-15. The objectives of the paper are to analyse the technological changes and growth of livestock output. For this purpose index number approach namely Tornqvist Theil approximation to Divisia Index was employed. The results revealed that overall average annual growth rate of livestock TFP index in Gujarat remained at 3.13 per cent at constant prices of 2004-05. The contribution of output growth stood at 12.13 per cent at current prices and 3.19 per cent at constant prices respectively during the study period. The results further indicated that productivity growth has been a significant factor in the performance of livestock sector in Gujarat over the last 45 years. The analysis also reveals that TFP remained negative during the period of 1980-90 due to four severe drought years in the period. Then it started increasing and reached the level of 11.05 per cent during 1990-2001, which was the maximum growth of TFP across the past 45 years. An in-depth study on further investment on livestock inputs and services would be useful to policy makers through higher allocation of resources for the development of livestock research in Gujarat.

**Keywords:** Total factor productivity, Input and output index, Food self-sufficiency, Livestock products.

**JEL.:** D24, Q12, Q13, Q18

I

INTRODUCTION

The animal husbandry sector plays an important role in gross state domestic product (GSDP) of Gujarat State, and the contribution of this sector is about 5.0 per cent. This sector also contributes to providing nutritive food, rich in animal protein, to the general public and ensure supplementary income to the economically weaker sections of the society like STs, SCs, small farmers, marginal farmers and agricultural labourers. In addition, it creates employment opportunities, if adopted on a commercial basis, besides providing household-based employment opportunities for rural households including women. Bullocks are the main source of draught power in agricultural operations and transport of agricultural products to the nearby markets.

---

\*National Dairy Research Institute, Karnal Haryana, †Assistant Professor, Kulbhaskar Ashram PG College, Allahabad State University, Uttar Pradesh.

The author acknowledges Indian Council of Agricultural Research for the financial support provided for conducting this research and completing my Ph.D. work. The author would like to acknowledge her mentor B.S. Chandel, Principal Scientist, NDRI for his continuous support and guidance.

The authors are highly grateful to the anonymous referee of the Journal for his valuable suggestions.

This is likely to remain so for a long period to come. Moreover, the agricultural production programme gets valuable organic manure provided by the livestock.. Gujarat is the home of some of the most important breeds of cattle and buffalo. *Gir* and *Kankrej* breeds of cows and *Mahesani*, *Jafarabadi*, *Banni* and *Surti* breeds of buffaloes are well known for their high milk yielding capacity. *Kankrej* bullocks are famous for their "Sawai-chal" and the cows of this breed are good milk producers. *Marwadi* and *Patanwadi* breeds of sheep of Gujarat are good wool producers. Four breeds of goats, viz. *Kachchhi*, *Zalawadi*, *Mahesani* and *Surti*, are good for mutton as well as milk production.

Livestock sector has been making rapid strides and has registered a spectacular growth in recent times, with positive impact on the livelihood of rural people mainly small farmers, marginal farmers and agricultural landless labourers by raising their living standards considerably. Gujarat state occupies a remarkable position in the country so far as livestock wealth and development are concerned. There is a strong justification to analyse livestock resources, value of livestock input and output, production of major livestock products, estimating technological changes in input and livestock output and their growth rates, and also the real value of output and its share in the total value of output. Keeping in view the above the present study has been undertaken to analyse the growth rates in livestock inputs and outputs leading to development of total factor productivity index for the livestock sector in Gujarat for the period 1970-71 to 2014-15.

## II

### DATA AND METHODOLOGY

#### *Estimation of Total Factor Productivity*

The Tornqvist-Theil TFP indices has been constructed for livestock sector at aggregate level for the period 1970-81 to 2014-15, following the methodology as given below.

$$\text{Total output index (QI}_t) = \text{QI}_{t-1} \pi_{j=1}^n (\text{Q}_{jt} / \text{Q}_{jt-1})^{1/2(R_{jt} - R_{jt-1})}$$

where,

QI<sub>t</sub>=Output index for period t

QI<sub>t-1</sub> =Output index for period t-1

Q<sub>jt</sub> =Output of j-th livestock product, (j = milk group, meat group, egg, wool and hairs, silkworm, cocoon and honey, increment in stock, dung and animal draft power) for period t

Q<sub>jt-1</sub> =Output of j-th livestock product, for period t-1

R<sub>jt</sub> =Share of output 'j' in total revenue from livestock products in t-th time period.

$R_{jt-1}$  = Share of output 'j' in total revenue from livestock products in t-1 time period.

$$\text{Total input index (XI}_t) = \text{XI}_{t-1} \pi_{i=1}^m (X_{it} / X_{it-1})^{1/2(\text{Sit} + \text{Sit-1})}$$

$\text{XI}_t$  = Input index for period t

$\text{XI}_{t-1}$  = Input index for period t-1

$X_{it}$  = Use of i-th input in period t (i = animal feed and fodder, labour and interest on population stock)

$X_{it-1}$  = Use of i-th input in period t-1

$\text{Sit}$  = Share of input 'i' in total cost in t-th time period

$\text{Sit-1}$  = Share of input 'i' in total cost in t-1 time period.

Total factor productivity index (TFPI)

$$\text{TFPI}_t = (\text{QI}_t / \text{XI}_t) \times 100$$

By specifying  $\text{QI}_{t-1}$  and  $\text{XI}_{t-1}$  equal to 100 in the initial years, the above equation provide the total output, total input and total factor productivity indices for the specified period 1980-81 (t=0) to 2011-12 (t=T). The indices are presented with base 1980-81= 100.

After construction of the output, input and TFP indices, the growth rates of these indices are computed using the compound interest formula as given below:

$$Y = ab^t$$

where,

Y = Total output / input / TFP indices

t = Time in years,

b = Compounding factor and  $b = (r+1)$

where,

r = Compound growth rate per unit output / input /TFP index per annum

Thus,

$$Y = a(r+1)^t$$

On making log transformation of this equation:

$$\text{Log } Y = \text{Log } a + t \text{ log } (1+r)$$

$$\text{Or } \text{Log } Y = \text{Log } a + t \text{ log } b$$

$$\text{Compound growth rate 'r' } = [(\text{Antilog of log } b) - 1] \times 100$$

### *Value of Output*

The state level data at current and constant prices (base 2004-05) on the value of output from livestock sector, disaggregated by seven groups, viz., milk group, meat group, eggs, wool and hair, silkworm cocoon and honey, dung and increment in stock were collected from Central Statistical Organisation for the period 1990-91 to 2004-05. For the earlier years of study, viz., 1970-61 to 1989-90, it was estimated based on methodology suggested by CSO.

### *Value of Input*

Unlike the value of output, CSO did not provide the data on value of livestock inputs at state level for any of study years. The input value was therefore, estimated based on relevant assumptions. To estimate the value of input, three inputs were considered namely, feed, labour and interest on value of stock. The detailed description of the data adjustments and assumptions are given below.

The conversion coefficients (adult cattle unit) are used as proposed by Kumbhare *et al.*, (1993); Bhati and Sen (1981) as given below:

Local cow	=	1.00	Local cow/Buffalo heifer >2 yrs	=	0.75
Crossbred cow	=	1.40	Calf of Buffalo and local cow >1 yr.	=	0.50
Buffalo	=	1.30	All calves < 1 yr.	=	0.33
Bullock/he-buffalo	=	1.00	Goat and Sheep	=	0.50
Local cow/Buffalo heifer >2 yrs	=	0.75	Other animals	=	1.00

### *Data on Production*

*Feed:* Livestock feed comprises (i) roughages which include straw and stalk, fodder (green and dry), grass, etc. and (ii) concentrates which are made up of oilcakes, crushed pulses, grains, wheat and rice bran, husk, etc. For roughages, 95 per cent of production of stalks and straws, the entire production of fodder, cane trash and grass in the agriculture sector are considered to be consumed by livestock. Therefore, the value of dry fodder taken as 95 per cent of value of straw and stalk produced in Gujarat. To estimate the fodder production, the data on area under fodder crops, both irrigated as well as unirrigated, area under pasture and grazing lands, area under forest were collected from *Land Utilisation Statistics* published by the Directorate of Economics and Statistics, Government of India. The average yield per hectare of 1.5 tonnes from the forest area, 0.75 tonne from permanent pasture and grazing lands, and 40 and 20 tonnes from irrigated and unirrigated areas, respectively, were used to estimate the fodder production (DAHD, Undated).

The concentrates are made up of oilcakes, crushed pulses, grains, rice and wheat bran. It was assumed that 2 per cent of wheat, 10 per cent of maize, 1 per cent of rice, 5 per cent of barley, sorghum, pearl millet and finger millet are fed to the animals (Jain *et al.*, 1996). The value of grains was collected from CSO. In addition to the

grains, wheat bran and rice polish have been estimated to be 6 per cent of wheat production and that of rice polish to be 3 per cent of rice production, respectively (Jain *et al.*, 1996). To estimate the production of oilseed cakes, the ratio of meal to seed was used as 55.7 per cent of rapeseed and mustard, 31.7 per cent of sunflower, 29.5 per cent of soyabean, 44.9 per cent of groundnut, 67 per cent of linseed, 39.4 per cent of seasmum and nigerseed, and 10.4 per cent of cottonseed (per bale) (Ranjhan *et al.*, 1999).

*Labour:* To work out the value of labour force engaged in livestock sector, the data of cultivators and agricultural labourers were collected from population census. Data in between the census was projected on the basis of the growth of the population of cultivators and agricultural labourers. Thereafter, after 1/4th male and 3/4th female in each category was considered to be employed for livestock rearing and maintenance. Further, it was assumed that three women were equivalent to two men (Elumalai and Pandey, 2004).

*Interest on Population Stock:* Interest of 9 per cent (Elumalai and Pandey, 2004) was charged on the value of livestock population. To work out the value of livestock population, all species of livestock were converted into adult cattle unit (ACU) and multiplied by prices of adult cattle.

*Prices:* The wholesale prices were used along with the production estimates as mentioned above for obtaining the value of output. The wholesale prices of meat, milk and some meat products (hides and skin), egg, wool, diesel and livestock prices were taken from Agricultural Prices in India or State Directorate of Economics and Statistics. Price of meat products (fat, heads, legs) and other meat and oesophagus were collected from Directorate of Marketing and Inspection for some initial years, while for later period these were estimated by moving the wholesale price index of relevant group. The average prices of diesel were collected from various issues of *Agricultural Prices in India* and from annual report of Ministry of Petroleum, Government of India. The prices of animals, oilcakes, fodder, grasses and wheat and rice bran were collected from *Agricultural Prices in India* and State Directorate of Economics and Statistics, while, the wage rates were collected from various issues of *Agricultural Wages in India*. Having all the information, the aggregation of total output and inputs in quantities and monetary terms were estimated for the estimation of total factor productivity index.

### III

#### RESULTS AND DISCUSSION

##### *Total Factor Productivity (TFP) Growth in Livestock Sector*

The measurement of TFP growth involves estimation of output and input indices of production. These output and input indices are computed from the value of output and input respectively. Therefore before discussing the level and pattern of TFP growth in livestock sector in Gujarat, the trends in value of output and input are

discussed for in-depth understanding of the sources of growth and sustainability of livestock sector in Gujarat.

### *Value of Output from Livestock: Composition and Growth*

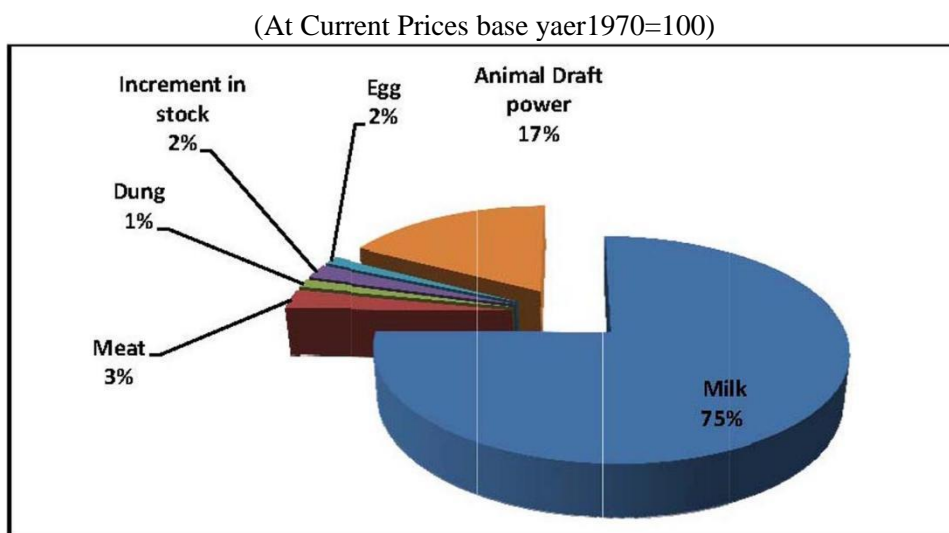
The average value of output from livestock sector at current as well as constant prices and the decadal growth rates are given in the Tables 1 and 2.

TABLE 1. VALUE OF OUTPUT FOR LIVESTOCK PRODUCTION AND ITS PERCENTAGE COMPOSITION (10 YEAR AVERAGE)

<i>(value in Rs. lakh)</i>									
At Current Prices									
Period/Items (1)	Milk Group (2)	Meat Group (3)	Silkworm and Cocoon (4)	Dung (5)	Increment in stock (6)	Wool and Hairs (7)	Egg (8)	Animal draft power (9)	Total value (10)
1970-71 to	22129.84	1524.93	0.21	959.25	634.55	164.38	618.63	15919.27	41940.17
1980-81	(52.77)	(3.64)	(0.00)	(2.29)	(1.51)	(0.39)	(1.48)	(37.96)	(100.00)
1980-81 to	93974.32	6960.02	0.51	3927.47	3340.85	336.84	1873.36	32215.76	142629.14
1990-91	(65.89)	(4.88)	(0.00)	(2.75)	(2.34)	(0.24)	(1.31)	(22.59)	(100.00)
1990-91 to	292525.76	25173.22	4.67	9082.70	11415.23	1094.68	4815.78	64448.25	408408.07
2000-01	(71.63)	(6.16)	(0.00)	(2.22)	(2.80)	(0.27)	(1.18)	(15.78)	(100.00)
2000-01 to	1533478.68	164456.20	14.68	43578.12	52216.16	1458.76	26309.02	383370.60	2204882.22
2014-15	(69.55)	(7.46)	(0.00)	(1.98)	(2.37)	(0.07)	(1.19)	(17.39)	(100.00)
At 2004-05 Prices									
Period/Items	Milk Group	Meat Group	Silkworm and Cocoon	Dung	Increment in stock	Wool and Hairs	Egg	Animal draft power	Total value
1970-71 to	219771.91	28783.62	0.85	50294.18	6458.67	7735.97	2532.05	178041.65	448744.45
1980-81	48.97	6.41	0.00	11.21	1.44	1.72	0.56	39.68	100.00
1980-81 to	405610.56	39572.64	0.69	88126.37	12630.29	9348.55	4693.44	208879.10	698965.13
1990-91	58.03	5.66	0.00	12.61	1.81	1.34	0.67	29.88	100.00
1990-91 to	603190.19	60392.82	4.92	169873.06	24367.56	13053.72	4990.92	153626.43	935908.75
2000-01	64.45	6.45	0.00	18.15	2.60	1.39	0.53	16.41	100.00
2000-01 to	927718.43	98062.14	1235.92	424978.73	27574.48	14069.74	23112.47	99001.20	1436224.99
2014-15	64.59	6.83	0.09	29.59	1.92	0.98	1.61	6.89	100.00

Source: CSO (2015), State wise Estimation of Value of Output from Agriculture and Allied Activities. National Account Statistics, Ministry of Statistics and Programme Implementation, New Delhi. Figures in parenthesis are percentage of total value of output from livestock.

*Milk Group*: Milk and milk products constitute the major shares in the value of output. In early 1970-71 it contributed nearly about more than half (52.77 per cent) of the total value and this proportion increased to about two-third (69.55 per cent) in 2014-15 (Figure 1). Over the years, there is a sustainable increase in the share of milk in total value of output at current prices (Table 1), however, in the real terms (at constant prices base 2004-05=100) a marginal decline in the same occurred during the 1960-61. The decline in milk output in real terms, as observed from the declining compound annual growth rate of real value of output from milk during 1970-71 to 1980-81 (Table 2) led to the decline in its proportionate share in total value of output from the livestock sector.



Source: CSO (2015). State wise Estimation of Value of Output from Agriculture and Allied Activities. National Account Statistics, Ministry of Statistics and Programme Implementation, New Delhi.

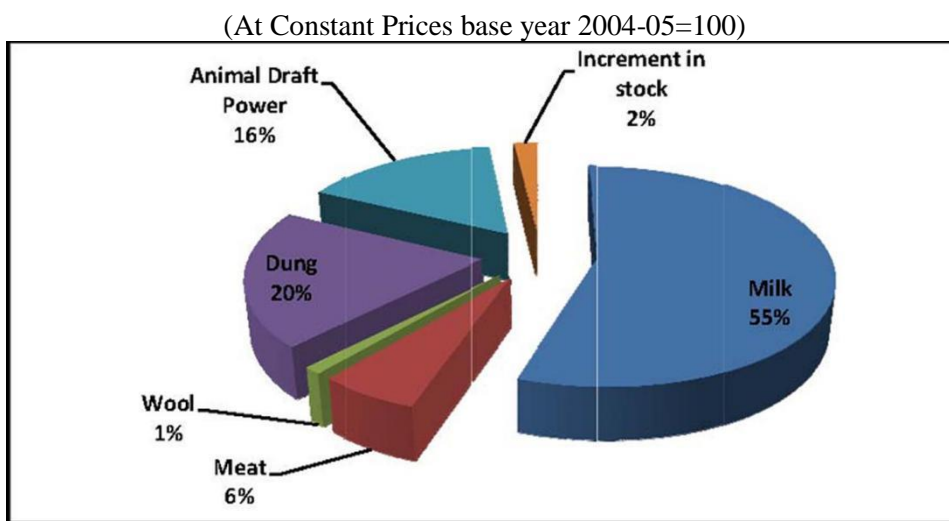


Figure 1. Composition of Value of Output from Livestock Sector in Gujarat (1970-71 to 2014-15).

*Animal Draft Power:* After the milk group, the second highest share (37.96 per cent) was from animal draft power (Figure 1). There was a slight difference in the share of this component till 2014-15 in terms of current and constant prices. For example in the quinquennium ending 1980-81, the value of this component was 37.96 per cent in total value of output at current prices.

TABLE 2. VALUE OF INPUT FOR LIVESTOCK PRODUCTION AND COMPOSITION OF INPUT VALUES AT CURRENT AND 2004-05 PRICES.

*(Value in Rs. Lakh)*

At Current Prices				
Period (1)	Livestock Feed (2)	Human Labour (3)	Livestock Population (4)	Total input (5)
1970-71 to 1980-81	34997.08 (62.04)	10527.29 (18.66)	10883.39 (19.29)	56407.77 (100.00)
1980-81 to 1990-91	85545.45 (61.66)	21988.16 (15.85)	31204.04 (22.49)	138737.65 (100.00)
1990-91 to 2000-01	155100.40 (52.52)	70856.16 (24.00)	69333.94 (23.48)	295290.50 (100.00)
2000-01 to 2014-15	448121.45 (47.03)	146552.87 (15.38)	358250.92 (37.59)	952925.25 (100.00)
At 2004-05 Prices				
1970-71 to 1980-81	115191.08 (59.26)	8070.46 (4.15)	71134.79 (36.59)	194396.34 (100.00)
1980-81 to 1990-91	107235.82 (45.88)	43232.15 (18.50)	83271.57 (35.63)	233739.55 (100.00)
1990-91 to 2000-01	127879.68 (49.47)	34341.58 (13.29)	96260.50 (37.24)	258481.76 (100.00)
2000-01 to 2014-15	171550.56 (51.99)	39648.81 (12.02)	118786.38 (36.00)	329985.76 (100.00)

Source: DAHD (2016), "Dry and Green Fodder Production-State-wise." Department of Animal Husbandry and Dairying Ministry of Agriculture Krishi Bhavan, New Delhi <http://dahd.nic.in>.

Figures in parentheses are percentage of total value of output from livestock.

*Meat:* After milk group and animal draft power, the third highest share (3.64 per cent) was meat group (Figure 1). There was a large difference in the share of this component till the 2014-15 in terms of current and constant prices. For instance, the value of 1980-81 was 3.64 per cent in total value of output at current prices, but this was as high as 6.41 per cent at constant prices, base 2004-05.

*Increment in Stock:* The percentage share of this component of output has increased from 1.51 per cent in 1970-71 to 2.37 per cent in 2014-15 at current prices (Figure 1). The value of the stock has increased from Rs.634.55 lakh in early 1970s to Rs. 52216.16 lakh during 2014-15 at current prices, while the real value has increased from Rs.6458.67 lakhs in 1970s to Rs.27574.48 lakhs in 2014-15.

*Egg:* Eggs have a minor share in the livestock output in Gujarat, and the percentage share of eggs in the total value of output continued to be less than 2 per cent at current price and in absolute terms its value has increased from Rs. 618.63 lacs to 26309.02 lakhs at current prices.

*Wool and Hairs:* The percentage share of this component has declined from 0.39 per cent during early 1970s to 0.07 per cent in 2014-15 at current prices (Figure 1). There was a notable increase in the value of wool and hairs at current as well as 2004-05 prices. The value of wool and hairs increased from Rs.164.38 lakhs during early 1970s to Rs.1458.76 lakhs in 2014-15 at current prices.



### *Value of Input of Livestock: Composition and Growth*

The input value included value of feed (green fodder, dry fodder and concentrates), labour and interest on value of livestock population. The nominal value of total input has increased from Rs.56407 lakh during the early 1970s to Rs. 952925.25 lakhs in 2000-01 to 2014-15 (Table 2).

*Livestock Feed:* Over the last 45 years, the share of feed and fodder ranked the highest in total value of inputs. But the share has declined from 62.04 per cent per annum during early 1970s to 47.03 per cent per annum in 2000-01 to 2014-15 at current prices. At constant prices, the share of feed and fodder fluctuated and came down in 1980s, late 1990s and during the current decade.

*Interest on Population Stock:* The relative factor share of interest on population stock has been continuously increasing over the period (Table 2). It has increased from around 20 per cent in early 1970s to 38 per cent in the quinquennium ending current decades at current prices (Table 2). All most similar pattern was found in terms of real value of this item. In fact the increase in share of interest on population stock was offset by decrease in the value share of animal feed. The nominal value of population stock has increased significantly from Rs. 10883.39 Lakh in early 1970s to Rs. 358250.92 Lakh during current decades at current prices.

*Labour:* During the overall period (1970-71 to 2014-15), the nominal value has increased from Rs. 10527.29 lakhs to Rs. 146552.87 lakhs, while the real value has increased relatively lower growth rate from around Rs.8070.46 lakh to Rs.39648.81 lakh during the entire period of study. At current prices the share of value of labour in total input value has increased from 5 per cent in the early 1970s to 12 per cent during the decades of 1980-1990, it fluctuated after 1990s and then started declining. At constant prices the share value fluctuated from 4.15 in 1970s to 12.02 per cent during 2000-2014 (Table 2).

### *Output, Input and TFP Indices*

It emerged from the discussion in the preceding section that over the period of time, there has been an increase in the value of output and inputs in the state. However, increasingly the expansion in value has come largely through the rise in prices.

After having discussed the share of input and output in total value of livestock sector, it may be useful to access the simultaneous changes in total output in response to changes in total inputs in the form of indices. The result of output, input and TFP Indices computed by using Tornqvist-Theil index and its growth over different time span are presented in Table 3 and discussed as under:

TABLE 3. COMPOUND ANNUAL GROWTH RATE OF OUTPUT, INPUT AND TFP INDICES IN LIVESTOCK PRODUCTION AT CURRENT AND 2004-05 PRICES

Periods/Items (1)	At Current Prices			At 2004-05 Prices		
	Output index (2)	Input index (3)	TFP index (4)	Output index (5)	Input index (6)	TFP index (7)
1970-71 to 1980-81	14.07	3.51	10.64	5.00	-2.54	7.74
1980-81 to 1990-91	12.96	9.36	1.34	6.77	7.39	-0.57
1990-91 to 2000-01	13.65	7.25	1.96	2.38	-7.81	11.05
2000-01 to 2014-15	13.22	11.49	4.96	4.06	1.91	2.11
1970-71 to 2014-15	12.21	8.22	3.39	4.21	1.04	3.13

*Current Prices:* The output index at current prices rose from 100 in base period 1970-71 (=100) to 339.5 in 1980-81 (compound annual growth rate 14 per cent). In subsequent decades the growth rate came down in 1980s to 12.96 per cent and again jumped to 13.65 per cent after 1990s (Table 3 and 4). The overall output index increased to 17344.3 in 2014-15 and registered a compound annual growth of 12.21 per cent. The TFP index declined after 1980s because of higher growth in input index (11 per cent) as compared to the growth in output index. This was due to four consecutive drought years during 1984-90, which led to increase in the cost of feed and fodder considerably. TFP picked up its growth from 1.34 during 1980s to 4.34 per cent in 2014-15 (Table 1). The overall TFP has increased at compound annual growth rate of 3.39 per cent during 1970-71 to 2014-15.

*Constant Prices:* In real terms the output index has increased at the annual compound growth rate of 3.19 per cent which was marginally more than the input index (2.33 per cent) during 1970-71 to 2014-15. Thus the TFP growth rate was low (0.84 per cent) indicating the overall sustainability of livestock sector was not very encouraging. Technology was only responsible for about 14 and 13 per cent increase in output growth at current prices. Baset *et al.* (2009) also concluded that the government should give more attention to allocate sufficient funds for further development of output and policy makers should give attention to minimise inputs price and maximise the output price by any means and the extension personnel should be encouraged to increase acreage under particular crop. The input oriented growth could not be sustained if further improvement does not occur. Both the input and output indices fluctuated over the period (Figure 3) but the fluctuations were more in input index than the output index. During the decades of 1970s input indices declined and became negative growth rate as compared to output index. Input index as well as output index both jumped to 7.30 and 6.77 per cent from -2.57 and 5 per cent for the decade of 1980-81 to 1990-91, respectively. This indicated that both the indices were increasing at a high growth rate but still the TFP growth rate was negative at -0.57 per cent for 1980s (Table 1).

During 1990s the annual compound growth for input and output indices were very low as compared to the previous decades of 1980s but the growth for input indices was much lower than output indices. However, the TFP index for that period was increasing at the rate of 11.05 per cent. There was a negligible difference in the

overall growth rate of TFP at current prices and in real prices. For instance the overall TFP was increasing at the rate of 3.39 per cent at current prices, whereas in real terms it is increasing at the rate of 3.13 per cent per annum.

(1970-71 to 2014-15)

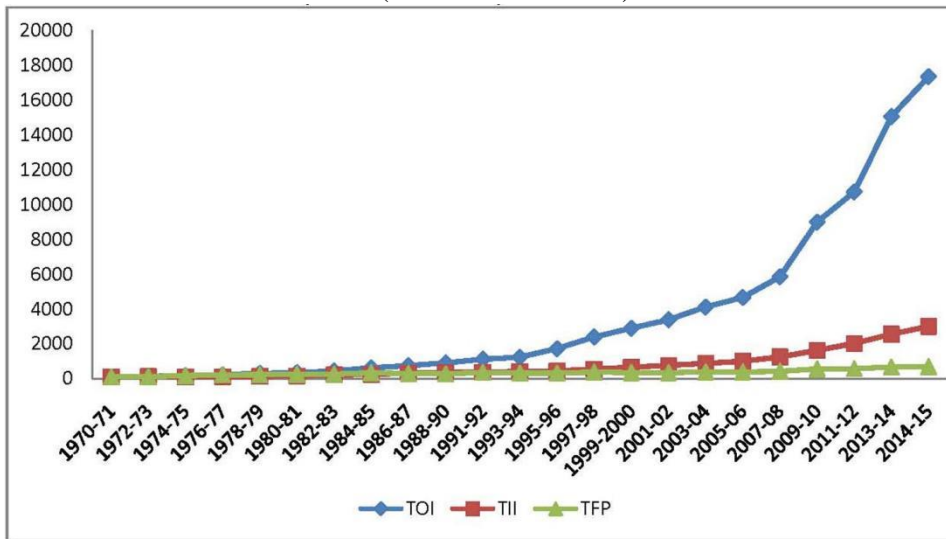


Figure 2. Trends in Input, Output and TFP Indices in Gujarat Livestock Sector at Current Prices.

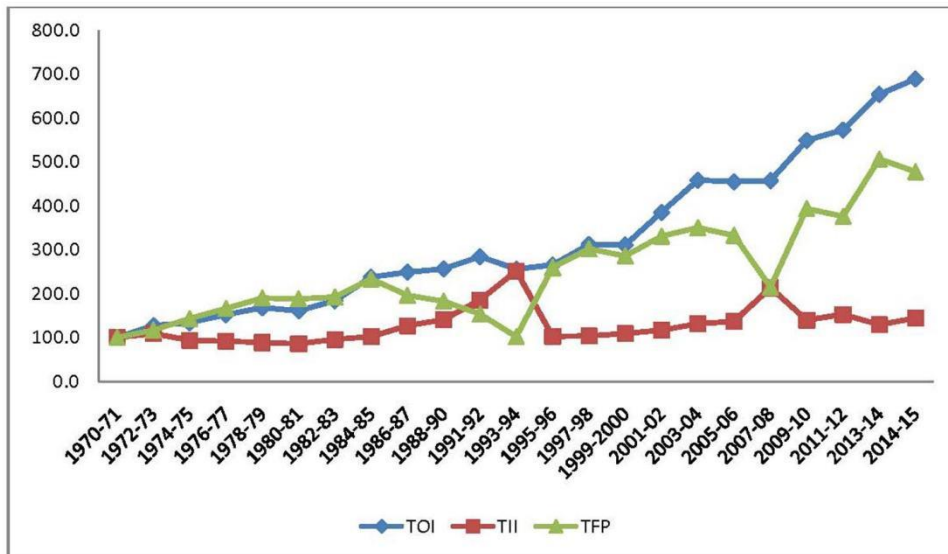


Figure 3. Trends in Input, Output and TFP Indices in Gujarat Livestock Sector at 2004-05 Prices.

TABLE 4. INPUT, OUTPUT AND TFP INDICES AT CURRENT AND 2004-05 PRICES

Year (1)	Current Prices			2004-05 Prices		
	TOI (2)	TII (3)	TFP (4)	TOI (5)	TII (6)	TFP (7)
1970-71	100.0	100.0	100.0	100.0	100.0	100.0
1971-72	106.3	109.1	97.5	103.1	113.7	90.7
1972-73	119.0	115.6	107.8	127.0	108.8	116.8
1973-74	142.3	115.1	124.6	127.0	102.5	123.9
1974-75	176.0	96.9	166.9	133.9	93.5	143.2
1975-76	196.1	101.7	185.8	143.9	87.5	164.5
1976-77	241.2	109.8	221.8	151.8	91.5	165.9
1977-78	268.8	121.8	222.9	157.0	87.4	179.6
1978-79	295.7	129.8	222.8	167.9	88.5	189.7
1979-80	292.6	142.9	208.9	154.3	86.6	178.1
1980-81	339.5	152.9	243.4	160.6	85.5	187.8
1981-82	403.7	218.0	248.8	161.1	90.9	177.2
1982-83	440.8	221.5	256.3	183.6	95.5	192.2
1983-84	495.9	220.6	278.4	173.9	141.2	123.1
1984-85	620.2	234.7	343.5	237.3	101.8	233.1
1985-86	682.0	275.6	334.3	244.5	110.7	220.8
1986-87	744.0	309.5	289.0	248.7	126.8	196.1
1987-88	814.2	371.2	255.6	245.3	148.4	165.3
1988-90	903.7	356.7	273.1	256.1	140.5	182.3
1990-91	1041.1	354.1	286.6	280.5	181.1	154.9
1991-92	1118.9	365.4	354.2	284.2	185.6	153.1
1992-93	1026.2	403.6	294.5	240.1	242.2	99.1
1993-94	1234.7	410.6	321.7	255.7	251.5	101.7
1994-95	1482.0	440.1	297.0	273.8	102.5	267.0
1995-96	1724.1	449.0	317.3	265.1	102.4	258.9
1996-97	2076.2	535.0	363.3	308.1	104.0	296.3
1997-98	2391.8	542.5	375.1	311.6	103.2	301.8
1998-99	2718.1	622.9	358.9	317.1	105.2	301.6
1999-2000	2896.9	653.2	346.6	310.6	108.8	285.6
2000-01	3244.3	688.1	358.8	335.0	109.1	306.9
2001-02	3380.7	759.3	338.0	385.2	116.5	330.6
2002-03	3724.9	831.2	361.4	511.5	113.4	450.9
2003-04	4117.8	871.6	388.1	458.1	130.9	349.9
2004-05	4270.1	887.0	391.1	456.7	125.7	363.2
2005-06	4666.9	1000.3	382.0	454.8	136.8	332.4
2006-07	5460.0	1103.5	430.4	469.2	126.0	372.5
2007-08	5848.9	1246.8	422.6	457.1	213.0	214.6
2008-09	6858.7	1452.0	468.1	492.9	137.3	359.0
2009-10	8994.5	1619.9	555.8	548.6	139.5	393.3
2010-11	9533.3	1785.1	534.2	516.0	153.8	335.5
2011-12	10727.2	2020.7	569.3	572.6	152.5	375.6
2012-13	13259.0	2330.0	616.1	625.5	154.5	404.8
2013-14	15056.4	2552.7	665.2	653.7	129.1	506.4
2014-15	17344.3	3002.1	681.9	688.7	144.3	477.3

## IV

## CONCLUSION AND POLICY IMPLICATIONS

It emerges from the discussion that the growth of output indices remained higher than that of input indices in all the periods. Better channelling of dairy co-operatives

structure in Gujarat played prominent role in realising higher output prices. Although the TFP indices was positive during the study period except in the period 1980-81 to 1990-91 at 2004-05 prices, where it became negative. Even in other periods also the TFP growth rate was very low indicating that the overall sustainability status was not encouraging in the state. The output growth was largely input-driven which would not sustain if further technological improvement does not take place. There were wide decadal variations and the real upswings started after 1980s. This momentum needs to be maintained to improve the sustainability of livestock sector in the state.

The productivity performance, measured by the growth in TFP, has shown considerable variations over the years and across the different livestock products. Silkworm, cocoon and milk products have enjoyed the highest benefit of technological change during the period 1970-2015 with its annual growth close to 13.65 per cent and 13.30 per cent respectively. The corresponding figures for milk at current prices and constant prices were 11.37 per cent and 10.97 per cent. Whereas at 2004-05 prices, the highest growth rate has been achieved by the silkworm and cocoon, which is close to the rate of 2.25 per cent, which is a remarkable rate of growth in Gujarat. The growth rate for milk group, meat group, animal draft power and wool and hairs were below 5 per cent at current prices of 2004-05. As TFP increases, the cost of production for livestock products decreases and consequently, prices fall and stabilise at a lower level. Therefore, both producers and consumers are benefited.

Since livestock contributes substantially in the agricultural GDP, therefore, policies should be devised to increase the productivity of this sector. Thus first priority should be to increase efficiency of this sector. However, our focus should not be diverted from technological change as it constituted a major part of TFP and is a major tool for rapid increase in livestock productivity to meet the increasing demand of meat and milk in the country. This could be done by strengthening the research capabilities through public private partnership so that new high yielding breeds of milking animals and high yielding varieties of fodder having more nutrients could be developed.

*Received July 2020.*

*Revision accepted February 2021.*

#### REFERENCES

- Bhati, D.K. and C. Sen (1981), "Agricultural Sustainability in Bihar: an Evaluation of Relative Status of Different Districts". *Journal of Agriculture Development and Policy*, Vol.9, No.2, pp.1-13.
- Bulletin of Animal Husbandry and Dairying Statistics (2012), Directorate of Economics & Statistics, KrishiBhavan, Gandhinagar, Government of Gujarat.
- Bulletin of Animal Husbandry and Dairying Statistics (2013), Directorate of Economics & Statistics, KrishiBhavan, Gandhinagar, Government of Gujarat.
- Bulletin of Animal Husbandry and Dairying Statistics (2014), Directorate of Economics & Statistics, KrishiBhavan, Gandhinagar, Government of Gujarat.
- DAHD (2016), "Dry and Green Fodder Production-State-wise." Department of Animal Husbandry and Dairying Ministry of Agriculture KrishiBhavan, New Delhi <http://dahd.nic.in>.

- DAHD (Undated), "Dry and Green Fodder Production – State-wise" Department of Animal Husbandry and Dairying Ministry of Agriculture KrishiBhavan, New Delhi. <http://dahd.nic.in>.
- Directorate of Economics and Statistics (2015), Basic Statistics - Gujarat. Directorate of Economics and Statistics, Gandhinagar, Gujarat.
- Directorate of Marketing and Inspection (1957), Marketing of Wool in India, Directorate of Marketing and Inspection, Department of Agriculture and Cooperation, Ministry of Agriculture, Faridabad.
- Directorate of Marketing and Inspection (1961), Marketing of Animal Fats and Certain Important By-products in India, Directorate of Marketing and Inspection, Department of Agriculture and Cooperation, Ministry of Agriculture, Faridabad.
- Directorate of Marketing and Inspection (1969), Marketing Pork and Pork Products in India, Directorate of Marketing and Inspection, Department of Agriculture and Cooperation, Ministry of Agriculture, Faridabad.
- Elumalai, K. and U.K. Pandey (2004), Technological Change in Livestock Sector of Haryana. *Indian Journal of Agricultural Economics*, Vol.59, No.2, April-June, pp.249-58.
- Government of India, *National Accounts Statistics*, Ministry of Statistics and Program Implementation, New Delhi (various years).
- Jain, D.K.; K.N.S. Sharma, T.K. Walli and S.N. v (1996), "Estimates of Nutrient Requirement and Availability for Bovine Population Across Major States in India." Technical Bulletin, NDRI, Karnal.
- Kumbhare, S.L.; K.N.S. Sharma and R.K. Patel (1993). "Standardisation of Bovine Units." *Indian Journal of Animal Science*, Vol.53, pp.543-547.
- Baset, M.A.; M.R. Karim & amp; M. Akter, (2009) "Measurement and Analysis of Total Factor Productivity Growth in Modern Variety Potato". *Journal of Agriculture and Rural Development*, Vol. 7, No.(1 and pp.;2), 65-71, ISSN 1810-1860, June 2009.
- Ranjhan, S.K., Sen, K.C. and Ray, S.N. (1999). *Nutritive Value of Indian Cattle Feeds and Feeding of Animals*, ICAR Publications, ICAR, New Delhi.