International Journal of Research in Economics and Social Sciences (IJRESS)
Available online at: http://euroasiapub.org
Vol. 7 Issue 11, November- 2017, pp. 20~29
ISSN(o): 2249-7382 | Impact Factor: 6.939 |

Comparing Total Factor Productivity of milk and major crops in Haryana: its implications on future investment

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This paper is drawn from my doctoral dissertation entitled, 'Investment Opportunities and Technological Change differentials between major crops and milk production in Haryana', awarded by National Dairy Research Institute, Karnal, Haryana in 2017.

ABSTRACT

The study compares the changes overtime in total factor productivity (TFP) of milk and the major crops in Haryana assuming that future investment by farmers will be incentivise in area of higher TFP growth. The analysis was based on time-series data on cost of cultivation collected from the Comprehensive Scheme for Studying Cost of Cultivation of Principal Crops brought out by the CACP for the period 1994-95 to 2010-11. The input and output indices were estimate using Tornqvist-Theil index and TFP index was taken as ratio of output index over input index. The change in TFP index overtime was estimated by compound annual growth rates in two sub time period and overall time period. The increase or decrease in TFP signifies contribution of factors (including technology) other than inputs. The study found that the growth in TFP of milk was just half of the growth in TFP of crop farming for the same period. This indicates lesser technological and support interventions undergone in milk production as compare to crops taken together. Nevertheless, the TFP of both the milk and crops in aggregate have increased at very low pace. The major reason for this was the decrease in TFP of wheat, rice and gram due to secondary effects of intensive cultivation. The reason for decrease in TFP of wheat and gram was the decrease in output index, while in case of rice, it was due to the higher growth in input index. The crops with positive growth rates in TFP were pearl millet, cotton, rapeseed-mustard and sugarcane. The study concluded that technological and infrastructural supports in the past had not favoured investment in milk production. Certainly, emphasis had shifted among crops away from popular rice wheat rotation.

Key words: Technological Change, Total Factor Productivity, Tornqvist-Theil Index, Milk, Haryana

Introduction

Indian agriculture has witnessed marvellous growth during the past several decades with the adoption of Green Revolution technology during late- 1960s. The Green Revolution phase was characterized by widespread adoption of improved varieties, boosting of productivities and resulting in a steady growth of food and non-food crops in India. It is felt that the potential of green revolution technologies has reached its limits and it is not able to sustain the future growth in Indian agriculture (Chand, 2012). In such circumstances, the growth of agriculture is prerequisite for overall development of the economy. The agricultural productivity growth is most significant among the key development challenges before India's economy, especially to such concerns as food availability and rural poverty. Given the binding of land constraint, agricultural growth in India depends on making land (for crops) more productive.

Indian agriculture is a small holder production. A large proportionate share of production is dominated by small and marginal landholdings of up to 2 hectares. With the marginalization of landholdings and other socio-economic constraints, Indian agriculture has become more susceptible to distress and got trapped in low input- low output cycle. With unfavourable land man ratio, crops alone cannot provide gainful employment and enough food for the country and there is a need for diversification within farming and with off farm employment. In the present economic, political and technological environment, farmers are to be assured of regular flow of income so that they find investment in agriculture as rewarding and generating comparable returns.

In India, the livestock and agricultural production are inter-dependent and both are crucial for the livelihood security of the rural population. Traditionally, crop production has accounted for over four-fifths of the agricultural output, but over the past two decades, a change has been experienced in agricultural production. The share of livestock in the agricultural production has risen sharply and now accounts for close to 30 per cent of the total agricultural output. Overall, the composition of agricultural output has gradually been shifting towards high-value crops and animal products, especially milk (Arora, 2013).

The study was conducted purposively in Haryana state, in view of the fact that, despite recent industrial development, Haryana is primarily an agricultural economy with preponderance of crops namely wheat, rice, bajra, mustard, sugarcane and cotton. The state is self-sufficient in food production and the second largest contributor to India's central pool of food grains. Haryana is the state that fits well with the requirement of established mixed production system, equal production possibilities and comparable infrastructural development both in milk and crops. In Haryana with stagnant growth of agriculture and high cost of land, the farmers have started looking towards for other alternatives like commercial dairying. The state is well known for its bovine wealth, it is also the home tract of Haryana cows and Murrah buffalo. Milk production in the Haryana state has reached about 83.81 lakh tones by 2015-16.

As Haryana is good in crop production as well as in livestock production. The main aim of the study was to measure the improvement in efficiency of input use and contribution of technical

change in agriculture and dairy sector and to determine favourable areas of future investment with respect to the crop cultivations and milk production. Technological improvement in particular sector is an important aspect of determining efficiency and profitability. If profitability and efficiency is low, the lack of technological improvements may be one of the reasons for the same.

The technological change was estimated using Total Factor Productivity (TFP) concept. The efficiency change analysis of TFP, attempts to measure the increases in total inputs. In the production function framework, TFP growth indicates technological progress, which represents shifts in the production function over time. In the context of India, technological progress measures the impact of shifts in production on account of irrigation, high-yielding varieties (HYVs), modern agriculture equipment, fertilizers, pesticides, etc. It also captures the effects of improved labour quality, better management practices, and intensive use of resources which lead to increased crop intensity, changes in cropping pattern in favour of high value-added crops etc. The Total factor productivity growth in agriculture increases income for the rural communities, which promotes their spending on the non-farm sector (Ellis, 2000; Himanshu *et al.*, 2011).

The change in TFP signify the technological change. Therefore, studying the "**Comparing Total Factor Productivity of milk and major crops in Haryana: its implications on future investment**" is important to answer the key question "Whether technological improvement was more in agricultural crops as compare to milk production and what are the preferred areas for future investment?"

Data and Methodology

Database: For the estimation of TFP growth for milk and seven major crops of Haryana, time-series unit level Cost of Cultivation data was collected for the period 1994-95 to 2010-11 from the Comprehensive Scheme for Studying Cost of Cultivation of Principal Crops brought out by the CACP, Directorate of Economics and Statistics, Department of Agricultural, Cooperation and Farmers' Welfare, Ministry of Agriculture GOI, New Delhi. From the unit level data, information on required parameters were compiled for seven major crops grown in Haryana, namely wheat, rice, bajra, gram, rapeseed-mustard, cotton and sugarcane, and milk production. Since all the data was in nominal values, it was deflated in order to remove the effect of inflation. The missing year data on inputs-use and output were estimated using interpolation based on trends in the available data.

Methodology: The extent of technological change took place in milk and crop farming was determined by calculating total factor productivity (TFP) index. The Divisia Tornqvist index was used in this study for computing TFP indices for milk and seven major crops of the states. The use of TFP indexes gained prominence since Diewert (1976, 1978) proved that Theil Tornqvist discrete approximation to the Divisia index was consistent in aggregation and superlative to linear homogeneous Translog production function. (For detailed methodological approach on TFP, refer

to Kumar and Rosegrant (1994), Mittal and Lal (2001), and Chatterjee and Gupta (2013). For milk production, TFP index was estimated taking into account two outputs and four inputs. Output index included main product (milk) and by-product (dung). The input index comprised, green fodder, dry fodder, concentrate and labour. In case of crop production, TFP index was estimated taking into account of two outputs and six inputs. Output index included main product and by product. The input index comprised, human labour, animal labour, machine labour, irrigation charges, seed and fertilizer.

The output index and input index were calculated with non-transitive options using TFPIP program developed by Coelli et al,1998.

Results and Discussion

The TFP is quite a useful indicator of changes in long term productivity. Growth in TFP signifies the increase or decrease in contribution of technology in production. Growth of TFP index is the growth of output index less the growth of input index. The trend of TFP index indicate whether production growth is taking place in a cost effective and sustainable manner or not. While growth in output can be achieved by using higher and higher level of inputs, it may not be sustainable in long run if incremental output involves increasing doses of incremental inputs. The TFP estimates pertain to a period of past seventeen years, starting from 1994-95 to 2010-11. This period has been further divided into two sub periods, viz. TP-I 1994-95 to 2001-02 and TP-II 2003-04 to 2010-11. The results have been discussed separately for each commodity and in combination.

TFP Growth for Milk: The growth rate in output, input and TFP indices of milk is given in Table 1. The results revealed that there was a marginal (0.32%) increase in TFP of milk at state level over the period 1994-95 to 2010-11. Though there were decrease in both output and input index but input index decreased at faster rate (-0.57 per cent per annum), than output index leading to increase in TFP index. The decrease in input index was because of better developed input market and improvement in marketing efficiency, making better inputs available at relatively cheaper rate.

Table 1: Temporal change in growth rates of output, input and TFP indices of milk

(Per cent)

Time Period	Output index	Input index	TFP index
TP-I 1994-95 to -2001-02	-0.16	3.03	-3.19
TP-II 2003-04 to 2010-11	-2.21	-0.88	-1.33
Overall Period 1994-95 to 2010-11	-0.25	-0.57	0.32

The review of growth rates over two sub time periods in state shows that input index has decelerated over time at a faster rate. It declined at the rate of (-0.88 %) per annum during TP-II (2003-04 to 2010-11). While it was increased (3.03%) during preceding period TP-I (1994-95 to 2001-02).

TFP Growth for Major crops: In case of crop production, TFP index was estimated taking into account of two outputs and six inputs. Output index included main product and by product. The input index comprised, human labour, animal labour, machine labour, irrigation charges, seed and fertilizer. The estimates of TFP growth for the major crops have shown wide variations across crops.

(i) Wheat: As it can be seen from the Table 2, there was a decrease of (-0.87%) per annum in TFP of wheat at state level. Though, there were decrease in both output and input index but output index decreased at faster rate (-0.94%), which led to decrease in TFP. The decrease in output index was because of output prices of wheat decreased in real value term as much higher rate in comparison to the input prices.

Table 2: Temporal change in growth rates of output, input and TFP indices of wheat

(Per cent)

Time Period	Output index	Input index	TFP index
TP-I 1994-95 to -2001-02	1.45	0.54	0.91
TP-II 2003-04 to 2010-11	1.33	-2.37	3.71
Overall Period 1994-95 to 2010-11	-0.94	-0.07	-0.87

While review of growth rates for two sub time period it is evident that TFP of wheat has exhibited positive growth rates in both sub time periods i.e. TP-I (0.91%) and TP-II (3.71%). The negative growth rate in overall period may be accounted due to the longer span of data used for analysis.

(iii) Rice: It is evident from the results displayed in table 3, that there was a negative growth in TFP index (-0.33 %) of rice at state level during 1994-95 to 2010-11. This was due to positive increase in growth rate of input index happened at much higher rate (1.08%) than the growth in output index (0.75%).

Table 3: Temporal change in growth rates of output, input and TFP indices of rice

(Per cent)

Time Period	Output index	Input index	TFP index
TP-I 1994-95 to -2001-02	-0.20	-0.87	0.67
TP-II 2003-04 to 2010-11	-3.12	-1.48	-1.63
Overall Period 1994-95 to 2010-11	0.75	1.08	-0.33

While analysing the growth rate trends at two sub time periods it can be inferred that in TP-II (2003-04 to 2010-11) output prices has decreased in real value terms at much lower rate may be accounted due to price fluctuations resulting to the negative growth in TFP index at state level.

(iv) Pearl-millet: The growth rate in output, input and TFP indices of pearl-millet is given in Table 4. The results revealed that there was a high increase (3.98%) in TFP of pearl-millet at state level during 1994-95 to 2010-11. It is due to decline in the growth of input index (-0.84%) as well as positive increase in the growth of output index (3.14%).

Table 4: Temporal change in growth rates of output, input and TFP indices of pearl-millet

(Per cent)

Time Period	Output index	Input index	TFP index
TP-I 1994-95 to -2001-02	2.80	1.33	1.47
TP-II 2003-04 to 2010-11	6.07	-0.04	6.11
Overall Period 1994-95 to 2010-11	3.14	-0.84	3.98

While review of TFP index growth rate over two sub time periods revealed that TFP has substantially increased in TP-II (2003-04 to 2010-11). This was mainly due to high yielding hybrid varieties of pearl-millet being used by farmers.

(v) Rapeseed-mustard: The growth rate in output, input and TFP indices of rapeseed-mustard is given in Table 5. The results displayed that there was an increase in TFP index for rapeseed-mustard at the rate of 1.71 per cent per annum at state level during 1994-95 to 2010-11.

Table 5: Temporal change in growth rates of output, input and TFP indices of rapeseed-mustard

(Per cent)

Time Period	Output index	Input index	TFP index
TP-I 1994-95 to -2001-02	7.31	8.04	-0.73
TP-II 2003-04 to 2010-11	5.59	-0.18	5.77
Overall Period 1994-95 to 2010-11	2.79	1.08	1.71

Though, there were increase in both output and input index but output index increased at faster rate (2.79%), which led to increase in TFP index. While review of TFP index growth rate over two sub time periods revealed that TFP has substantially increased (5.77) in TP-II (2003-04 to 2010-11).

(vi) Gram: It is evident from the results displayed in table 6, that there was a decrease (-0.21%) in TFP of gram at state level during 1994-95 to 2010-11. Though, there were decrease in both output and input index but output index decreased at faster rate (-3.95%), which led to decrease in TFP Index.

Table 6: Temporal change in growth rates of output, input and TFP indices of gram

(Per cent)

Time Period	Output index	Input index	TFP index
TP-I 1994-95 to -2001-02	-4.82	0.13	-4.95
TP-II 2003-04 to 2010-11	1.43	-5.24	6.67
Overall Period 1994-95 to 2010-11	-3.95	-3.75	-0.21

The decrease in output index was because of output prices of gram were decreased in real value term by higher rate in comparison to the input prices and hence resulting in negative growth rate of TFP index.

(vii) Cotton: The growth rate in output, input and TFP indices of cotton is given in Table 7. The results revealed that there was an increase in TFP index of cotton at the rate 1.29 per cent per annum at state level during 1994-95 to 2010-11.

Table 7: Temporal change in growth rates of output, input and TFP indices of cotton

(Per cent)

Time Period	Output index	Input index	TFP index
TP-I 1994-95 to -2001-02	-2.34	2.96	-5.30
TP-II 2003-04 to 2010-11	7.55	3.56	3.99
Overall Period 1994-95 to 2010-11	3.75	2.46	1.29

Though, there were increase in both output and input index but output index increased at faster rate (3.75%), which led to increase in TFP index. The positive growth in TFP at state level has mainly arose from increase in output index due to introduction and high adoption of improved variety of BT cotton during initial years of TP-II (2003-04 to 2010-11).

(viii) Sugarcane: The growth rate in output, input and TFP indices of sugarcane is given in Table 8. The results revealed that there was an increase in TFP index of sugarcane at the rate of 3.33 per cent per annum at state level for overall time period (1994-95 to 2010-11).

Table 8: Temporal change in growth rates of output, input and TFP indices of sugarcane

(Per cent)

Time Period	Output index	Input index	TFP index
TP-I 1994-95 to -2001-02	2.53	-2.89	5.42
TP-II 2003-04 to 2010-11	-0.16	6.51	-6.67
Overall Period 1994-95 to 2010-11	0.97	-2.36	3.33

The positive growth in TFP index is accounted due to negative growth rate in input index (-2.36%) and positive growth rate in output index (0.97%). Similar to overall period, in sub time Period TP-I (1994-95 to 2001-02), TFP index was found positive (5.42%) due to positive growth rate in output index (2.53%) and negative growth rate in input index (-2.89%). In contrary to this in TP-II (2003-04 to 2010-11) the growth rate in TFP index was found negative (-6.67%) due to negative growth in output index (-0.16%) and higher growth rate in input index (6.51%).

State level growth rate in TFP indices of milk production and crop farming: The growth rate in output, input and TFP indices for aggregate crop and milk production are given in Table 9. The results revealed that there was an increase in TFP index of aggregate crop at the rate of 0.87 per cent per annum at state level for the time period 1994-95 to 2010-11. The positive growth in TFP

index for aggregate crops was mainly accounted due to high growth rate in output index (1.27%) than the input index (0. 40%).

Table 9: State level Growth rates in Output, Input and TFP indices for milk and major crops, 1994-95 to 2010-11

(Per cent)

Particulars	Output index	Input index	TFP index
Milk	-0.25	-0.57	0.32
Wheat	-0.94	-0.07	-0.87
Rice	0.75	1.08	-0.33
Pearl-millet	3.14	-0.84	3.98
Gram	-3.95	-3.75	-0.21
Rapeseed-Mustard	2.79	1.08	1.71
Cotton	3.75	2.46	1.29
Sugarcane	0.97	-2.36	3.33
Aggregate Crops	1.27	0.40	0.87

It can be inferred that the positive growth in TFP index for aggregate crop was mainly on account of increase in the yield of pearl-millet, sugarcane, rapeseed-mustard and cotton. The TFP of crops has increased at a growth rate more than double of milk production.

Figure 1 depicts the trends in TFP indices of milk and aggregate crop farming during the period of 1994-95 to 2010-11. It can be seen that the TFP index trend for milk is lower than that of crop.

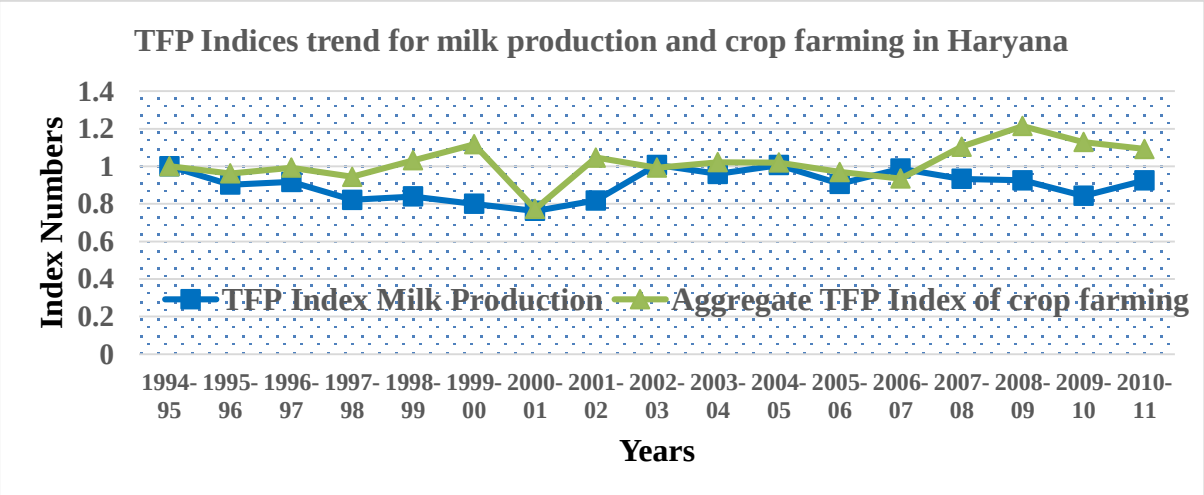
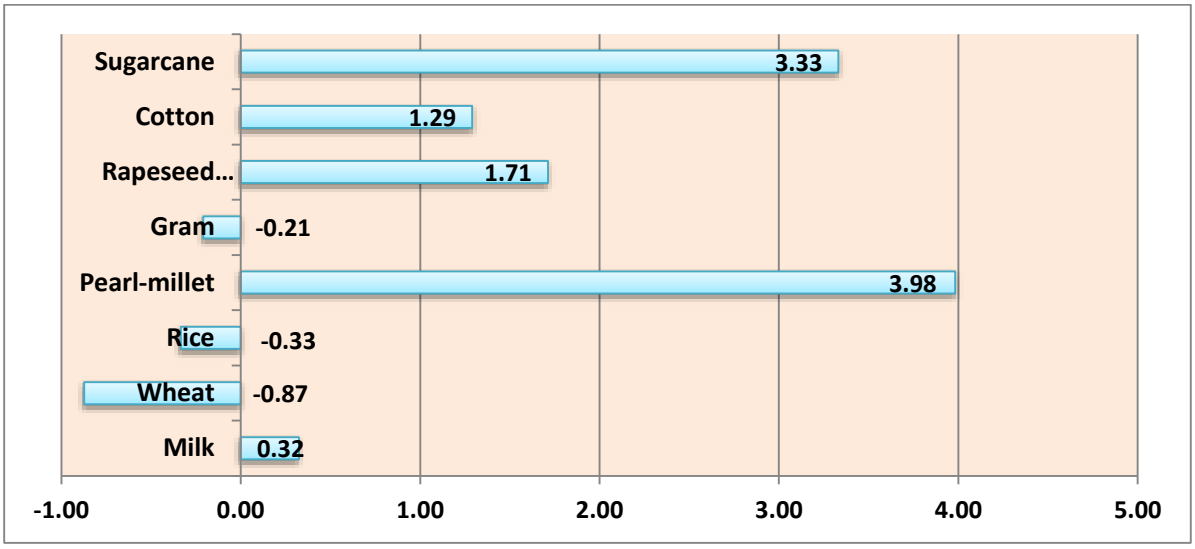


Figure 1: Trends in TFP indices of milk production and crop farming in Haryana

The trends of growth rate in TFP indices of milk and major crops over the years (1994-95

to 2010-11) are being depicted in Figure 2.



Figures 2: State level trends in growth rate of TFP indices for milk and major crops (1994-95 to 2010-11)

It was noted that growth rate of TFP index of milk in the state was positive but lower. The overall picture of growth rate for milk reveal that technical factors are marginally leading to the growth of output and decrease in cost. Besides milk, the TFP growth rate was positive for pearl-millet (3.98%), sugarcane (3.33%), rapeseed-mustard (1.71%) and cotton (1.29%), while, it was negative in case of wheat, rice and gram which occupied 70% of gross cropped area in Haryana.

Hence there is a high need of further technological advancement for milk production to enable farmers to divert their limited investment towards milk production. This will help in increasing the yield and decrease the cost through efficient utilization of the limited resources.

Conclusion

The growth in TFP is a significant source of output growth as well as of investment growth. It could be concluded by comparing the TFP growth rate of milk and major crops for the study time period (1994-95 to 2010-11) that the growth in TFP of milk was just half of the growth in TFP of crop farming. This indicates lesser technological and support interventions undergone in milk production as compare to crops taken together. Nevertheless, the TFP of both the milk and crops in aggregate have increased at very low pace. In milk, though both output and input indices were having negative growth but the rate of decrease in input index has decreased faster than the output index. The study concluded that technological and infrastructural supports in the past had not favoured investment in milk production. Certainly, emphasis had shifted among crops away from popular rice wheat rotation. The preference of the farmers shifted from the major food grain crops wheat, rice to the pearl millet, rapeseed-mustard and commercial crops like sugarcane and cotton. In major crops like wheat, rice and gram, TFP has decreased due to secondary effects of intensive cultivation. The decrease in TFP of wheat and gram was due to decrease in output index of these crops, while in case of rice, it was due to the higher growth in input index. The crops with

positive growth rates in TFP were pearl millet, cotton, rapeseed-mustard and sugarcane. In case of cotton, the positive growth in TFP has mainly arose from increase in output index due to introduction and high adoption of improved variety of BT cotton during initial years of TP-II (2003-04 to 2010-11). The continuous cultivation of Bt. Cotton without crop rotation may result in soil health degradation and emergence of more serious pests and diseases. The higher growth rate in TFP of pearl millet and sugarcane had been possible due to increase in productivity and decrease in use of inputs because of varietal break through. In case of rapeseed-mustard, the input use has increased along with increase in yield but the increase in yield was higher than input with improvement of technical efficiency.

Policy Recommendations

This is observed from the study that the increasing cost of crop inputs and limits to further expansion in cultivable area linked to the weather disruptions poses a threat to the income of the farmer. Hence this is recommended that farmer needs to divert his future investment towards more assured and better remunerative options such as dairying. As it needs lesser capital investment and provides continuous flow of income over the year. Dairying adds significant value to the nutritional and food security. As the demand for quality and nutritive food is increasing day by day and disposable consumer income is increasing, hence dairy sector has to be made more market driven rather than only for subsistence purposes. Various new initiatives can be take in this direction to provide dairy farmers better forward linkages for their dairy produce. The government should encourage the small and marginal farmers to focus on dairy investment and good quality inputs in dairy sector should be provided along with proper extension services to reduce the gap in "Lab to Land" for better dissemination of improved technologies and good dairying practices.

The government should deliver continuous support to major grain crops necessary for food security of the region such as wheat and rice on regular basis for sustainable TFP growth, in term of new technologies and favourable macroeconomic policies.

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