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# Performance Analysis of Food Processing Industries in Punjab using Data **Envelopment Analysis**

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## Abstract

Food Processing Industries of Punjab have been statistically analysed for finding the dominant industry, growth of different food processing industries of Punjab and competitive analysis of relevant food processing industries at All - India Level. This paper has analysed development and financial performance, with special reference to working capital management, of selected food-processing industries, food grains milling, edible oilseeds processing, sugarcane processing and milk processing all of which produce mass consumption goods. It prioritises these industries for development based on the performance criteria and discusses strategies.

**Keywords:** Food processing industries; Data envelopment analysis; Agriculture, Productivity; Green revolution

## Introduction

Agriculture plays a vital role in the initial stages of economic development. Agriculture provides food, employment, and savings besides contributing to gross domestic product of the country and earning foreign exchange. History shows that all the developed economies of the world today were agarian at one point of time and have transitioned through manufacturing and services sector development to figure amongst the developed economies.

To the extent, agriculture remained the main source of national income and occupation since independence. Till 1960s, agriculture and allied activities contributed nearly 50% to India's national income. After 70 years of independence, the share of agriculture in total national income has declined from 50% in 1949- 50 to 17.32% in 2016-17. However, still agriculture is the major source of employment and provides employment to 48.9% of the total employment.

A milestone in Indian agriculture was achieved when Green Revolution in mid 60s took place. The Green Revolution in India was not a miracle, but was the result of proper public policies, the creation of appropriate infrastructure, inspiring leadership, dedicated workers and the hard work of the Indian peasantry. However, despite tremendous increase in food production, the progress in agriculture remained unequal in different states. Only few states could cultivate the benefits of Green Revolution and among them Punjab took the lead.

But after 1980s, momentum gained by green revolution started getting fading away and the success story carved by green revolution restricted itself to wheat and rice crops only. The period witnessed slow growth in productivity of agriculture due to depleting water table as well as increasing soil salinity and micro-nutrient deficiencies accompanied by rising costs of production leading to stagnating income of the farmers [1]. The expenditure on crop production increased because of costly inputs. The new farm technology adopted by farmers since mid-sixties required heavy investment of capital in the form of farm machinery, irrigation equipments and other inputs like chemical fertilizers, pesticides/insecticides, etc. to maintain pace [2]. Farmers had to spend huge amounts of cash on purchasing market supplied farm inputs and machinery to carry out their production operations [3]. Farmers needed finance for carrying out the cultivation as well as for subsistence. Farmers borrowed year after year, yet they were not able to clear off the loans either because the loans got larger or agricultural produce could not commensurate with the amount to be returned [4]. All these factors became responsible for increasing indebtedness among the farmers to the extent, that farmers of Punjab resorted to committing suicides [5].

Thus, the Green Revolution turned out to be conflict-producing instead of conflict-reducing. Economic prosperity and the lead of Punjab in terms of per capita income is now history and other states have surpassed this long lead. There is growing need to provide respite to the farmers and bring back the lost glory of the state. Accordingly, we need to emulate the growth pattern of other states of India.

In recent decades, different states have brought substantial changes in the pattern of production, consumption, and trade in Indian agriculture. One change is the shift in production and consumption from food grains to high value agricultural commodities such as fruits and vegetables, milk and milk products, meat, eggs, fish and processed food products. Trade in high value products is increasingly displacing exports of traditional commodities such as rice, sugar, tea, coffee, tobacco, etc. With an increase in the number of working couples, there is a paucity of time to prepare the meals by married females which has necessitated the requirement of ready-to-cook foods. Thus, high value agricultural crops are assuming increasing weightage day by day. Moreover, due to improvement in technology, physical input of the people has decreased because of which their lifestyle has become sedentary which has deteriorated the quality of life. Therefore, people are becoming more diet conscious and relying on healthy foods with lower carbohydrate content and with low cholesterol edible oils. e.g., zero-percent trans-fat snacks and biscuits, slim milk, whole wheat products, oats, soya-beans products, corn flakes etc. Consumers have become aggressive in demanding better, safer, and convenient food products and are willing to pay a higher price for health and

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convenience. This has given a stimulus to food processing industry in particular.

A strong and dynamic food processing sector plays significant role in the overall economic setup of a country. The sector provides vital linkages and synergies between industry and agriculture and has been identified as a sector having immediate potential for growth of the economy. Processing also helps in generating rural employment, additionally processed fruits and vegetables are a source of earning foreign exchange [6].

Keeping into consideration the inherent problems in Indian Agriculture, noted researchers like Dr. Johl, Dr. Sucha and Singh Gill etc. have thoroughly put forward the case of developing Food Processing Industries in the state on the war footing basis. The present study is an attempt to find out the performance and efficiency of food processing industries in the state [7-10].

# Data Base and Methodology

In general, productivity is defined as a ratio of a volume measure of output to a volume measure of input use (OECD Manual, 2001:11). In this paper, we refer to TFP, which is a comprehensive measure involving all factors of production. There are four different approaches to measure the TFP of the industrial sector. These are as follows: (1) Growth accounting approach, (2) Least squares econometrics production models, (3) Stochastic production frontier approach, and (4) Non-parametric approach. This paper examines the productivity growth of the food processing sector in Punjab using non-parametric method of DEA. DEA was originally designed to study the relative efficiencies of different firms or managerial units assumed to have a common best practice production technology available. The method enables a comparison among firms on the basis of the extent to which inputs are used efficiently in the production of output, given the technology. However, there are ample numbers of studies, where DEA technique has been used to study performance at aggregate country level, performance of two-digit disaggregated manufacturing sector across the regions, and a set of time series data on aggregate manufacturing sector [11]. In case of India, Ray uses the state-level data on manufacturing inputs and outputs for the year 1985-86 through 1995-96 to measure Tornqvist and Malmquist indices of productivity growth. According to him, the annual rate of productivity growth is higher during the post-reform period than in the pre-reform period and there is a tendency towards convergence in the productivity growth rates across states. The justification for using DEA in this study primarily lies on the implicit assumption that all the food processing industries in Punjab share a common production practice. The study has taken the gross value added as output after subtracting the intermediate inputs and expenditure on power and fuel from gross output. Hence by taking gross value added as output and labour and capital as the two inputs in the production function, we neutralise the heterogeneity impact of using different production function for different industries.

Using the DEA, the Malmquist indices are computed based on annual time series data for the period 1980-81 to 2013-14. The Malmquist index has several advantages, like no need to specify a specific functional form, no assumption regarding market structure or economic behaviour, it does not require information on prices, and it allows for inefficiency. Using DEA, Malmquist indices of productivity change are decomposable into components of changes in pure technical efficiency, technical progress, and scale efficiency, and hence our analysis enables us to identify the sources of productivity growth and shift the leading industries from the lagging ones. The Malmquist TFP Indices and Estimation Procedure in DEA

The description below draws primarily upon the work of Fare et al. The Malmquist productivity index is explained using the distance function. Distance functions are of two types: input-oriented and output-oriented. Input-oriented distance functions look for input quantities to be proportionally reduced without changing the output quantities produced. Output-oriented distance functions consider the output quantities to be proportionally expanded without altering the input quantities used. The Malmquist approach is most commonly used for output comparisons. Hence, we adopt an output-oriented approach of computing TFP in this paper. However, in case of constant returns to scale (CRS), output- and input-oriented measures provide equivalent measures of technical efficiency. In this paper, we assume that all the industries are operating at an optimal scale.

However, the Data Envelopment Analysis can be used to solve this problem. Following Fare et al. the Malmquist (output oriented) TFP change index. The Malmquist TFP index calculates the change in productivity between two points by estimating the ratios of the distances of each point relative to a common technology. The Malmquist input oriented TFP change index between the base period t & the following period t+1 is defined as:

$$M(y_{t,}x_{t,}y_{t+1,}x_{t+1}) = \left[\frac{d_{t+1}(Y_{t+1,}X_{t+1})}{d_{t}(Y_{t,},X_{t})}X\frac{d_{t}(Y_{t+1},X_{t+1})}{d_{t+1}(Y_{t+1},X_{t+1})}\right]^{1/2}$$

A value of M greater than unity implies a positive TFP growth from period t to period t+1. Otherwise, a value of M less than one indicates a TFP decline. Equation (1) is geometric mean of two TFP indices. The first index is calculated with respect to period t technology, while the second index is evaluated with respect to period t+1 technology.

The advantage of the Malmquist index is that it allows the researcher to distinguish between shifts in the production frontier (technological change, TC) and movements of firms towards the frontier technical efficiency change, TEC). The measure of technical efficiency must be between 0 and 1.

Total Factor Productivity Change Index=

$$\frac{D^{t}(y^{t}, x^{t})}{D^{t+1}(y^{t+1}, x^{t+1})} \times \left[\frac{D^{t+1}(y_{t+1}, x_{t+1})}{D^{t}(y^{t+1}, x^{t+1})} \times \frac{D^{t+1}(y^{t}, x^{t})}{D^{t}(y^{t}, x^{t})}\right]^{1/2}$$
Technological Change Index =  $\left[\frac{D^{t+1}(y_{t+1}, x_{t+1})}{D^{t}(y^{t+1}, x^{t+1})} \times \frac{D^{t+1}(y^{t}, x^{t})}{D^{t}(y^{t}, x^{t})}\right]^{1/2}$ 
Technical Efficiency Change Index =  $\left[\frac{D^{t+1}(CRS)(y_{t+1}, x_{t+1})}{D^{t}(CRS)(y^{t}, x^{t})}\right]$ 
Pure Technical Efficiency Change Index =  $\left[\frac{D^{t+1}(VRS)(y_{t+1}, x_{t+1})}{D^{t}(VRS)(y^{t}, x^{t})}\right]$ 
Scale Efficiency Change Index =  $\left[\frac{D^{t+1}(CRS)(y_{t+1}, x_{t+1})}{D^{t}(CRS)(y^{t}, x^{t})}\right]$ 
(1)

#### Data sources and measurement of variables

The data on all the relevant variables are drawn from the ASI for

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the period 1980-81 to 2013-14 for all the two-digit industries in Punjab. Two National Industrial Classification (NIC) codes have been used for the above period of the study. The details of NIC codes (1987 and 1998) of the industries covered in this study have been provided. In the case of some industries, figures are not available for certain years; therefore, data have been extrapolated for these years. All monetary figures have been deflated by using appropriate national price deflators since price deflators are not available at the state level.

In the present study, gross value added is used as a measure of output. Following Goldar [12] and Kumar [13], we preferred gross value added as a measure of output in place of net value added because depreciation charges in the Indian industries are known to be highly arbitrary and rarely represent actual capital consumption. The wholesale price index for two-digit manufacturing products (base 1993-94=100) has been used for arriving the figures on real gross value added. Since ASI does not provide data series on 'man-hours', the present study uses the number of employees as a measure of labour input. A serious limitation of the 'number of employees' as a measure of labour input is that it treats workers and persons other than workers as perfect substitutes. In the present study, we do not make any attempt to correct labour data for quality change arising out of age, sex and educational composition of the labour force.

The secondary data regarding food processing industries have been collected from Ministry of Statistical and Programme Implementation (MOSPI) since 1980- 81 and have been statistically analysed for finding the dominant industry, growth of different food processing industries of Punjab and competitive analysis of relevant food processing industries at All- India Level. The following tables representing Dominance, Growth and Competitiveness interprets that Manufacture of Grain Mill, starches and starch products and prepared animal feeds industry (Industry Group-III) is the most dominant industry amongst five.

# **Dominance and Growth**

Above Dominance shows that manufacture of Grain Mill products, starches and starch products Industry is the dominating industry amongst the total food processing industries of Punjab from 1980-81 to 2015-16 (Table 1).

Growth table below illustrates growth of Meat Industry to around 2% in Net Value added and Profits from 1980-1991, only 6% in NVA and Profits from 1990-2001 and 20% in NVA and Profits from 2000-2016. Meat Industry shows a growth of only 23% in number of factories from 1980-1991, 7% from 1990-2001, 7% from 2000-2016 and overall growth of around 2% in the number of factories from 1980-2016. Meat Industry shows an overall growth of 16% in NVA and Profits from 1980- 2016 (Table 2).

Dairy Industry in below Table 3 shows growth of around 28% in Net Value added and Profits from 1980-1991, around 22% in NVA and Profits from 1990-2001 and decline of around 4% in NVA and 20% in Profits from 2000- 2016. Dairy Industry shows an overall growth of 11% in NVA and 3% in Profits from 1980-2016. Table 4 shows that there is a growth of 18% in the number of factories from 1980-1991, 10% from 1990-2001 and only 2% from 2001-2016 and exhibited an overall growth of 5% in the number of Factories from 1980-2016.

Manufacture of Grain Mill, Starches and other Starch products and prepared animal feeds industry exhibits a growth rate of around 12% in Net Value added and 4% in Profits from 1980-1991, around 14% in NVA from 1990-2001 and 7% in NVA and 60% in Profits from 2001-2016. Manufacture of Grain Mill, Starches and other Starch products and prepared animal feeds Industry in Table 5 shows an overall growth of 4% in number of factories, 12% in Output, 11% in NVA and 38% in Profits from 1980-2016.

Slaughtering, preparation and preservation of meat         1980-81         17.33         10.95         17.56         33.33         34.9         18.72         22           1990-91         13.49         12.93         18.94         37.98         41.17         18.37         20.18           2000-01         5.39         7.09         14.06         24.07         26.94         8.16         8.51           2010-11         10.95         12.12         24.05         25.5         27.52         6.17         1.49           2015-16         7.89         12.76         14.47         23.02         20.17         50.31         160.23           Manufacture of dairy product         1980-81         1.47         3.5         16.17         11.89         11.28         17.51         28.16           2000-01         3.03         8.23         12.61         23.49         18.76         31.46         48.81           2000-11         2.05         6.6         5.88         12.99         13.41         9.14         1.21           2015-16         2.14         8.77         11.86         14.82         15.36         9.87         1.82           Manufacture of grain mill products, and prepared animal feeds         1980-81 <th>Industry</th> <th>Characteristics/Year</th> <th>Number of factories (no.)</th> <th>Number of workers (no.)</th> <th>Invested capital</th> <th>Total output</th> <th>Total inputs</th> <th>Net value added</th> <th>Profit</th>	Industry	Characteristics/Year	Number of factories (no.)	Number of workers (no.)	Invested capital	Total output	Total inputs	Net value added	Profit
preservation of meat         1990-91         13.49         12.93         18.94         37.98         41.17         18.37         20.18           2000-01         5.39         7.09         14.06         24.07         26.94         8.16         8.51           2010-11         10.95         12.12         24.05         25.5         27.52         6.17         1.49           2015-16         7.89         12.76         14.47         23.02         20.17         50.31         160.23           Manufacture of dairy product         1980-81         1.47         3.5         16.17         11.89         11.28         17.51         26.16           1990-91         1.41         6         17.51         13.83         11.57         31.46         48.81           2000-01         3.03         8.23         12.61         23.49         18.74         52.24         88.96           2010-11         2.05         6.6         5.88         12.99         13.41         9.14         12.12           2015-16         2.14         8.77         11.86         14.82         15.36         9.87         1.82           starches and starch products, and prepared animal feeds         1980-81         72.8	Slaughtering, preparation and	1980-81	17.33	10.95	17.56	33.33	34.9	18.72	22
2000-01         5.39         7.09         14.06         24.07         26.94         8.16         8.51           2010-11         10.95         12.12         24.05         25.5         27.52         6.17         1.49           2015-16         7.89         12.76         14.47         23.02         20.17         50.31         160.23           Manufacture of dairy product         1990-91         1.41         6         17.51         13.83         11.57         31.46         48.81           2000-01         3.03         8.23         12.61         23.49         18.78         52.24         88.96           2010-11         2.05         6.6         5.88         12.99         13.41         9.14         1.21           Manufacture of grain mill products, and prepared animal feeds         1980-81         7.28         56.83         44.64         42.75         43.66         34.67         20.58           starches and starch products, and prepared animal feeds         1990-91         78.12         61.5         33.67         31         32.25         17.7         4.36           2010-11         79.86         61.99         46.14         34.12         36         15.25         1.03           2010-11 <td>preservation of meat</td> <td>1990-91</td> <td>13.49</td> <td>12.93</td> <td>18.94</td> <td>37.98</td> <td>41.17</td> <td>18.37</td> <td>20.18</td>	preservation of meat	1990-91	13.49	12.93	18.94	37.98	41.17	18.37	20.18
2010-11         10.95         12.12         24.05         25.5         27.52         6.17         1.49           2015-16         7.89         12.76         14.47         23.02         20.17         50.31         160.23           Manufacture of dairy product         1980-81         1.47         3.5         16.17         11.89         11.28         17.51         28.05           1990-91         1.41         6         17.51         13.83         11.57         31.46         48.81           2000-01         3.03         8.23         12.61         23.49         18.78         52.24         88.96           2010-11         2.05         6.6         5.88         12.99         13.41         9.14         1.21           2015-16         2.14         8.77         11.86         14.82         15.36         9.87         1.82           Manufacture of grain mill products, starches and starch products, and 1990-91         78.12         61.5         33.67         31         32.25         17.7         4.36           2000-01         82.2         60.48         30.53         32.99         35.81         16.47         -0.13           2015-16         84.04         57.33         48.01 <t< td=""><td></td><td>2000-01</td><td>5.39</td><td>7.09</td><td>14.06</td><td>24.07</td><td>26.94</td><td>8.16</td><td>8.51</td></t<>		2000-01	5.39	7.09	14.06	24.07	26.94	8.16	8.51
2015-16         7.89         12.76         14.47         23.02         20.17         50.31         160.23           Manufacture of dairy product         1980-81         1.47         3.5         16.17         11.89         11.28         17.51         26.16           1990-91         1.41         6         17.51         13.83         11.57         31.46         48.81           2000-01         3.03         8.23         12.61         23.49         18.78         52.24         48.96           2010-11         2.05         6.6         5.88         12.99         13.41         9.14         1.21           2015-16         2.14         8.77         11.86         14.82         15.36         9.87         1.82           Manufacture of grain mill products, starches and starch products, and prepared animal feeds         1990-91         78.12         61.5         33.67         31         32.25         17.7         4.36           2000-01         82.2         60.48         30.53         32.99         35.81         16.67         -0.13           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2010-11         79.86         61.9 </td <td></td> <td>2010-11</td> <td>10.95</td> <td>12.12</td> <td>24.05</td> <td>25.5</td> <td>27.52</td> <td>6.17</td> <td>1.49</td>		2010-11	10.95	12.12	24.05	25.5	27.52	6.17	1.49
Manufacture of dairy product         1980-81         1.47         3.5         16.17         11.89         11.28         17.51         26.16           1990-91         1.41         6         17.51         13.83         11.57         31.46         48.81           2000-01         3.03         8.23         12.61         23.49         18.78         52.24         88.96           2010-11         2.05         6.6         5.88         12.99         13.41         9.14         1.21           2015-16         2.14         8.77         11.86         14.82         15.36         9.87         1.82           Manufacture of grain mill products, and prepared animal feeds         1990-91         78.12         61.5         33.67         31         32.25         17.7         4.36           2000-01         82.2         60.48         30.53         32.99         35.81         16.47         -0.13           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2015-16         84.04         57.93         48.01		2015-16	7.89	12.76	14.47	23.02	20.17	50.31	160.23
1990-91         1.41         6         17.51         13.83         11.57         31.46         48.81           2000-01         3.03         8.23         12.61         23.49         18.78         52.24         88.96           2010-11         2.05         6.6         5.88         12.99         13.41         9.14         1.21           2015-16         2.14         8.77         11.86         14.82         15.36         9.87         1.82           Manufacture of grain mill products, and prepared animal feeds         1980-81         72.8         56.83         44.64         42.75         43.66         34.67         20.58           2000-01         82.2         60.48         30.53         32.99         35.81         16.47         -0.13           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2010-11         3.61         12.65         22.21         10.08         9.17	Manufacture of dairy product	1980-81	1.47	3.5	16.17	11.89	11.28	17.51	26.16
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2015-16         2.14         8.77         11.86         14.82         15.36         9.87         1.82           Manufacture of grain mill products, starches and starch products, and prepared animal feeds         1980-81         72.8         56.83         44.64         42.75         43.66         34.67         20.58           2000-01         82.2         60.48         30.53         32.99         35.81         16.47         -0.13           2000-01         82.2         60.48         30.53         32.99         35.81         16.47         -0.13           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2015-16         84.04         57.93         48.01         40.85         43.5         17.6         -51.92           Manufacture of other food products         1980-81         6.13         24.72         16.2         8.54         6.87         24.39         28.71           1990-91         3.61         12.65         22.21         10.08         9.17         15.37         6.7           2000-01         5.8         16.69         31.19         11.94         11.9         15.33         -1.05           2010-11         3.23		2010-11	2.05	6.6	5.88	12.99	13.41	9.14	1.21
Manufacture of grain mill products, starches and starch products, and prepared animal feeds         1980-81         72.8         56.83         44.64         42.75         43.66         34.67         20.58           1990-91         78.12         61.5         33.67         31         32.25         17.7         4.36           2000-01         82.2         60.48         30.53         32.99         35.81         16.47         -0.13           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2015-16         84.04         57.93         48.01         40.85         43.5         17.6         -51.92           Manufacture of other food products         1980-81         6.13         24.72         16.2         8.54         6.87         24.39         28.71           1990-91         3.61         12.65         22.21         10.08         9.17         15.33         -1.05           2010-11         3.23         11.21         11.67         9.89         9.61         12.04         -0.95           2015-16         2.79		2015-16	2.14	8.77	11.86	14.82	15.36	9.87	1.82
starches and starch products, and prepared animal feeds         1990-91         78.12         61.5         33.67         31         32.25         17.7         -4.36           2000-01         82.2         60.48         30.53         32.99         35.81         16.47         -0.13           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2015-16         84.04         57.93         48.01         40.85         43.5         17.6         -51.92           Manufacture of other food products         1980-81         6.13         24.72         16.2         8.54         6.87         24.39         28.71           1990-91         3.61         12.65         22.21         10.08         9.17         15.37         6.7           2000-01         5.8         16.69         31.19         11.94         11.19         15.33         -1.05           2010-11         3.23         11.21         11.67         9.89         9.61         12.04         -0.95           2015-16         2.79         12.58         14.84         9.37         9.13         11.43         -15.99           Manufacture of beverages         1980-81         2.27	Manufacture of grain mill products,	1980-81	72.8	56.83	44.64	42.75	43.66	34.67	20.58
prepared animal feeds         2000-01         82.2         60.48         30.53         32.99         35.81         16.47         -0.13           2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2015-16         84.04         57.93         48.01         40.85         43.5         17.6         -51.92           Manufacture of other food products         1980-81         6.13         24.72         16.2         8.54         6.87         24.39         28.71           1990-91         3.61         12.65         22.21         10.08         9.17         15.37         6.7           2000-01         5.8         16.69         31.19         11.94         11.19         15.33         -1.05           2010-11         3.23         11.21         11.67         9.89         9.61         12.04         -0.95           2010-11         3.23         11.21         11.67         9.89         9.61         12.04         -0.95           2015-16         2.79         12.58         14.84         9.37         9.13         11.43         -15.99           Manufacture of beverages         1980-81         2.27         3.99	starches and starch products, and	1990-91	78.12	61.5	33.67	31	32.25	17.7	-4.36
2010-11         79.86         61.09         46.14         34.12         36         15.25         1.03           2015-16         84.04         57.93         48.01         40.85         43.5         17.6         -51.92           Manufacture of other food products         1980-81         6.13         24.72         16.2         8.54         6.87         24.39         28.71           1990-91         3.61         12.65         22.21         10.08         9.17         15.37         6.7           2000-01         5.8         16.69         31.19         11.94         11.19         15.33         -1.05           2010-11         3.23         11.21         11.67         9.89         9.61         12.04         -0.95           2015-16         2.79         12.58         14.84         9.37         9.13         11.43         -15.99           Manufacture of beverages         1980-81         2.27         3.99         5.42         3.49         3.29         4.72         2.55           1990-91         3.37         6.93         7.67         7.11         5.85         17.1         28.67           2000-01         3.57         7.51         11.61         7.51         7.2	prepared animal feeds	2000-01	82.2	60.48	30.53	32.99	35.81	16.47	-0.13
2015-16         84.04         57.93         48.01         40.85         43.5         17.6         -51.92           Manufacture of other food products         1980-81         6.13         24.72         16.2         8.54         6.87         24.39         28.71           1990-91         3.61         12.65         22.21         10.08         9.17         15.37         6.7           2000-01         5.8         16.69         31.19         11.94         11.19         15.33         -1.05           2010-11         3.23         11.21         11.67         9.89         9.61         12.04         -0.95           2015-16         2.79         12.58         14.84         9.37         9.13         11.43         -15.99           Manufacture of beverages         1980-81         2.27         3.99         5.42         3.49         3.29         4.72         2.55           1990-91         3.37         6.93         7.67         7.11         5.85         17.1         28.67           2000-01         3.57         7.51         11.61         7.51         7.28         7.8         3.71           2010-11         3.91         8.98         12.25         17.51         13.45		2010-11	79.86	61.09	46.14	34.12	36	15.25	1.03
Manufacture of other food products         1980-81         6.13         24.72         16.2         8.54         6.87         24.39         28.71           1990-91         3.61         12.65         22.21         10.08         9.17         15.37         6.7           2000-01         5.8         16.69         31.19         11.94         11.19         15.33         -1.05           2010-11         3.23         11.21         11.67         9.89         9.61         12.04         -0.95           2015-16         2.79         12.58         14.84         9.37         9.13         11.43         -15.99           Manufacture of beverages         1980-81         2.27         3.99         5.42         3.49         3.29         4.72         2.55           1990-91         3.37         6.93         7.67         7.11         5.85         17.1         28.67           2000-01         3.57         7.51         11.61         7.51         7.28         7.8         3.71           2010-11         3.91         8.98         12.25         17.51         13.45         57.4         97.22           2015-16         3.14         7.95         10.81         11.93         11.85 </td <td></td> <td>2015-16</td> <td>84.04</td> <td>57.93</td> <td>48.01</td> <td>40.85</td> <td>43.5</td> <td>17.6</td> <td>-51.92</td>		2015-16	84.04	57.93	48.01	40.85	43.5	17.6	-51.92
1990-91         3.61         12.65         22.21         10.08         9.17         15.37         6.7           2000-01         5.8         16.69         31.19         11.94         11.19         15.33         -1.05           2010-11         3.23         11.21         11.67         9.89         9.61         12.04         -0.95           2015-16         2.79         12.58         14.84         9.37         9.13         11.43         -15.99           Manufacture of beverages         1980-81         2.27         3.99         5.42         3.49         3.29         4.72         2.55           1990-91         3.37         6.93         7.67         7.11         5.85         17.1         28.67           2000-01         3.57         7.51         11.61         7.51         7.28         7.8         3.71           20010-11         3.91         8.98         12.25         17.51         13.45         57.4         97.22           2015-16         3.14         7.95         10.81         11.93         11.85         10.78         5.86	Manufacture of other food products	1980-81	6.13	24.72	16.2	8.54	6.87	24.39	28.71
2000-01         5.8         16.69         31.19         11.94         11.19         15.33         -1.05           2010-11         3.23         11.21         11.67         9.89         9.61         12.04         -0.95           2015-16         2.79         12.58         14.84         9.37         9.13         11.43         -15.99           Manufacture of beverages         1980-81         2.27         3.99         5.42         3.49         3.29         4.72         2.55           1990-91         3.37         6.93         7.67         7.11         5.85         17.1         28.67           2000-01         3.57         7.51         11.61         7.51         7.28         7.8         3.71           2010-11         3.91         8.98         12.25         17.51         13.45         57.4         97.22           2015-16         3.14         7.95         10.81         11.93         11.85         10.78         5.86		1990-91	3.61	12.65	22.21	10.08	9.17	15.37	6.7
2010-11         3.23         11.21         11.67         9.89         9.61         12.04         -0.95           2015-16         2.79         12.58         14.84         9.37         9.13         11.43         -15.99           Manufacture of beverages         1980-81         2.27         3.99         5.42         3.49         3.29         4.72         2.55           1990-91         3.37         6.93         7.67         7.11         5.85         17.1         28.67           2000-01         3.57         7.51         11.61         7.51         7.28         7.8         3.71           2010-11         3.91         8.98         12.25         17.51         13.45         57.4         97.22           2015-16         3.14         7.95         10.81         11.93         11.85         10.78         5.86		2000-01	5.8	16.69	31.19	11.94	11.19	15.33	-1.05
2015-16         2.79         12.58         14.84         9.37         9.13         11.43         -15.99           Manufacture of beverages         1980-81         2.27         3.99         5.42         3.49         3.29         4.72         2.55           1990-91         3.37         6.93         7.67         7.11         5.85         17.1         28.67           2000-01         3.57         7.51         11.61         7.51         7.28         7.8         3.71           2010-11         3.91         8.98         12.25         17.51         13.45         57.4         97.22           2015-16         3.14         7.95         10.81         11.93         11.85         10.78         5.86		2010-11	3.23	11.21	11.67	9.89	9.61	12.04	-0.95
Manufacture of beverages         1980-81         2.27         3.99         5.42         3.49         3.29         4.72         2.55           1990-91         3.37         6.93         7.67         7.11         5.85         17.1         28.67           2000-01         3.57         7.51         11.61         7.51         7.28         7.8         3.71           2010-11         3.91         8.98         12.25         17.51         13.45         57.4         97.22           2015-16         3.14         7.95         10.81         11.93         11.85         10.78         5.86		2015-16	2.79	12.58	14.84	9.37	9.13	11.43	-15.99
1990-913.376.937.677.115.8517.128.672000-013.577.5111.617.517.287.83.712010-113.918.9812.2517.5113.4557.497.222015-163.147.9510.8111.9311.8510.785.86	Manufacture of beverages	1980-81	2.27	3.99	5.42	3.49	3.29	4.72	2.55
2000-013.577.5111.617.517.287.83.712010-113.918.9812.2517.5113.4557.497.222015-163.147.9510.8111.9311.8510.785.86		1990-91	3.37	6.93	7.67	7.11	5.85	17.1	28.67
2010-113.918.9812.2517.5113.4557.497.222015-163.147.9510.8111.9311.8510.785.86		2000-01	3.57	7.51	11.61	7.51	7.28	7.8	3.71
2015-16 3.14 7.95 10.81 11.93 11.85 10.78 5.86		2010-11	3.91	8.98	12.25	17.51	13.45	57.4	97.22
		2015-16	3.14	7.95	10.81	11.93	11.85	10.78	5.86

Table 1: Dominance table

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Characteristics/ year	Number of factories (no.)	Number of workers (no.)	Invested capital	Total output	Total inputs	Net value added	Profit
1980-81	130	3792	2423.89	18508.76	17429.48	927.69	433.38
Def 1980-81	130	3792	1213.51	9266.35	8726.01	464.45	216.97
1990-91	172	6889	17732.7	108854.92	102339.42	5651.59	2669.9
Def 1990-91	172	6889	8877.82	54497.88	51235.91	2829.45	1336.68
Growth	2.84	6.15	22.02	19.38	19.36	19.81	19.94
1990-91	172	6889	17732.7	108854.92	102339.42	5651.59	2669.9
Def 1990-91	172	6889	8396.99	51546.2	48460.91	2676.2	1264.28
2000-01	80	6325	48681	214428	201416	10383	5139
Def 2000-01	80	6325	23051.97	101538.36	95376.77	4916.67	2433.48
Growth	-7.37	-0.85	10.63	7.01	7.01	6.27	6.77
2000-01	80	6325	48681	214428	201416	10383	5139
Def 2000-01	80	6325	23478.78	103418.35	97142.67	5007.71	2478.53
2015-16	229	13602	266849	878728	677628	189544	149421
Def 2015-16	229	13602	128700.93	423809.37	326819.1	91416.82	72065.55
Growth	6.79	4.9	11.22	9.22	7.88	19.9	23.44
1980-81	130	3792	2423.89	18508.76	17429.48	927.69	433.38
Def 1980-81	130	3792	277.15	2116.28	1992.88	106.07	49.55
2015-16	229	13602	266849	878728	677628	189544	149421
Def 2015-16	229	13602	30511.38	100473.31	77479.64	21672.36	17084.72
Overall growth	1.59	3.61	13.95	11.32	10.7	15.92	17.62

Table 2: Growth Table: Industry Group-I Slaughtering, preparation and preservation of meat.

Characteristics/Year	Number of factories (no.)	Number of workers (no.)	Invested capital	Total output	Total inputs	Net value added	Profit
1980-81	11	1212	2232.3	660188	5633.27	867.81	515.31
Def 1980-81	11	1212	1117.59	330521.06	2820.28	434.47	257.99
1990-91	18	3197	16395.35	3963072	28747.09	9679.46	6458.86
Def 1990-91	18	3197	8208.28	1984099.6	14392.14	4845.99	3233.61
Growth	5.05	10.19	22.07	19.63	17.7	27.27	28.77
1990-91	18	3197	16395.35	3963072	28747.09	9679.46	6458.86
Def 1990-91	18	3197	7763.71	1876638.39	13612.65	4583.53	3058.47
2000-01	45	7334	43669	209282	140432	66467	53705
Def 2000-01	45	7334	20678.64	99101.56	66498.94	31474.2	25431
Growth	9.6	8.66	10.29	-25.48	17.19	21.25	23.59
2000-01	45	7334	43669	209282	140432	66467	53705
Def 2000-01	45	7334	21061.5	100936.44	67730.17	32056.95	25901.85
2015-16	62	9348	218792	565677	516114	37199	1698
Def 2015-16	62	9348	105523.1	272825.28	248921.11	17941.03	818.94
Growth	2.02	1.53	10.6	6.41	8.48	-3.56	-19.42
1980-81	11	1212	2232.3	660188	5633.27	867.81	515.31
Def 1980-81	11	1212	255.24	75485.56	644.11	99.22	58.92
2015-16	62	9348	218792	565677	516114	37199	1698
Def 2015-16	62	9348	25016.56	64679.22	59012.21	4253.31	194.15
Overall Growth	4.92	5.84	13.58	-0.43	13.37	11	3.37

Table 3: Industry group-II manufacture of dairy product.

Manufacture of other food products industry exhibits a growth rate of around 14% in Net Value added and 5% in Profits from 1980-1991, around 15% in NVA from 1990-2001 and 3% in NVA and 22% in Profits from 2000-2016. Manufacture of other food products Industry shows an overall growth of 10% in NVA and 33% in Profits from 1980-2016. Table 6 also shows that there is a growth of 6% in the number of factories from 1990-2001 and exhibited an overall growth of around 2% in the number of factories and only 1% growth in the number of workers from 1980-2016.

Manufacture of beverages industry exhibits a growth rate of around 36% in Net Value added and 54% in Profits from 1980-1991,

around 6% in NVA from 1990-2001 and 9% in NVA and 6% in Profits from 2001-2016. Manufacture of other food products Industry shows an overall growth of 15% in NVA and 14% in Profits from 1980-2016. Table 6 also shows that there is an overall growth of 5% both in the number of Factories and in the number of workers from 1980-2016.

# Market share

Table 7 shows the market share analysis of different food processing industries of Punjab and its trend from 1980-81 to 2015-16. The share of Dairy Industry, Grain, Starch and Beverages Industry has increased while that for Meat and Other Food Products Industry has declined. The following figures shows the trends of market share of different food

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Characteristics/Year	Number of factories (no.)	Number of workers (no.)	Invested capital	Total output	Total inputs	Net value added	Profit
1980-81	546	19674	6162.94	23742.58	21802.48	1718.45	1405.44
Def 1980-81	546	19674	3085.46	11886.65	10915.34	860.34	703.62
1990-91	996	32778	31524.15	88840.78	80150.37	5444.68	423.05
Def 1990-91	996	32778	15782.47	44477.86	40127.03	2725.86	211.8
Growth	6.2	5.24	17.73	14.11	13.9	12.22	-11.31
1990-91	996	32778	31524.15	88840.78	80150.37	5444.68	-576.95
Def 1990-91	996	32778	14927.67	42068.88	37953.7	2578.23	-273.2
2000-01	1219	53929	105716	293900	267705	20956	-76
Def 2000-01	1219	53929	50059.83	139170.83	126766.68	9923.32	-35.99
Growth	2.04	5.11	12.86	12.71	12.82	14.43	-18.35
2000-01	1219	53929	105716	293900	267705	20956	-76
Def 2000-01	1219	53929	50986.69	141747.59	129113.77	10107.05	-36.65
2015-16	2438	61739	885477	1558944	1461634	66312	-48414
Def 2015-16	3657	61739	427064.4	751876.66	704944.18	31982.19	-23350.01
Growth	7.11	0.85	14.21	10.99	11.19	7.47	49.71
1980-81	546	19674	6162.94	23742.58	21802.48	1718.45	-594.56
Def 1980-81	546	19674	704.67	2714.71	2492.88	196.49	-67.98
2015-16	2438	61739	885477	1558944	1461634	66312	-49414
Def 2015-16	2438	61739	101244.98	178248.85	167122.48	7582.08	-5649.97
Overall Growth	4.24	3.23	14.8	12.33	12.39	10.68	13.06

Table 4: Industry group-III manufacture of grain mill products, starches and prepared animal feeds.

Characteristics/Year	Number of factories (no.)	Number of workers (no.)	Invested capital	Total output	Total inputs	Net value added	Profit
1980-81	46	8558	2237.06	4742.48	3432.47	1208.95	565.49
Def 1980-81	46	8558	1119.98	2374.31	1718.46	605.26	283.11
1990-91	46	6742	20794.53	28891.92	22780.77	4730.11	887.16
Def 1990-91	46	6742	10410.72	14464.65	11405.12	2368.11	444.15
Growth	0	-2.36	24.98	19.81	20.84	14.62	4.61
1990-91	46	6742	20794.53	28891.92	22780.77	4730.11	1587.16
Def 1990-91	46	6742	9846.86	13681.23	10787.41	2239.85	751.57
2000-01	86	14886	108008	106336	83660	19507	64
Def 2000-01	86	14886	51145.16	50353.42	39615.62	9237.17	30.31
Growth	6.46	8.24	17.91	13.92	13.89	15.22	-27.46
2000-01	86	14886	108008	106336	83660	19507	-636
Def 2000-01	86	14886	52092.12	51285.71	40349.11	9408.2	-306.74
2015-16	81	13405	273677	357656	306715	43044	-14916
Def 2015-16	81	13405	131994.06	172497.02	147928.25	20760.07	-7193.97
Growth	-0.37	-0.65	5.98	7.88	8.46	5.07	21.8
1980-81	46	8558	2237.06	4742.48	3432.47	1208.95	-434.51
Def 1980-81	46	8558	255.78	542.25	392.47	138.23	-49.68
2015-16	81	13405	273677	357656	306715	43044	-15916
Def 2015-16	81	13405	31292.09	40894.2	35069.63	4921.63	-1819.82
Overall Growth	1.58	1.25	14.28	12.76	13.29	10.43	10.52

Table 5: Industry Group-IV Manufacture of other food products.

processing industries of Punjab and with respect to whole industries operating in the state from 1980-81 to 2015-16 (Figures 1 and 2).

# **Empirical Results**

The output-oriented Malmquist indices of productivity change are computed using the DEA. Table 8 presents the mean estimates (geometric means) of Malmquist indices of different Food Processing Industries of Punjab from 1980-81 to 2015-16.

The above table indicates that there has considerable growth of Food Processing Industry of Punjab due to positive growth of TFP (Total Factor Productivity). All the Food Processing Industries except Meat Industry shows negative growth in TEC (Technical Efficiency Change). PTEC (Pure Technical Efficiency Change) for Meat and Beverages Industry remains constant whereas for Dairy, Grain, Starch and other Food Products Industry, it is negative which implies that these industries lack in the learning process. On the other hand, Scale Efficiency for Meat Industry is positive indicates that this industry has increased its productivity by increasing their size. Above results shows that in Meat, Diary, Beverages Industry and Other food products industry, both Total Factor Productivity Change and Technological Change contributed to the growth of overall efficiency.

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Characteristics/Year	Number of factories (no.)	Number of workers (no.)	Invested capital	Total output	Total inputs	Net value added	Profit
1980-81	17	1383	748.83	1936.73	1641.7	233.93	50.31
Def 1980-81	17	1383	374.9	969.62	821.91	117.12	25.19
1990-91	43	3692	7176.78	20377.46	14543.41	5261.01	3793.32
Def 1990-91	43	3692	3593.03	10201.91	7281.11	2633.91	1899.11
Growth	9.72	10.32	25.36	26.53	24.38	36.52	54.08
1990-91	43	3692	7176.78	20377.46	14543.41	5261.01	3793.32
Def 1990-91	43	3692	3398.43	9649.36	6886.76	2491.25	1796.26
2000-01	53	6693	40221	66941	54401	9925	2238
Def 2000-01	53	6693	19045.9	31698.65	25760.57	4699.8	1059.76
Growth	2.11	6.13	18.81	12.63	14.1	6.55	-5.14
2000-01	53	6693	40221	66941	54401	9925	2238
Def 2000-01	53	6693	19398.54	32285.56	26237.53	4786.81	1079.38
2015-16	91	8472	199394	455416	398216	40630	5466
Def 2015-16	91	8472	96167.47	219646.54	192059.06	19595.8	2636.24
Growth	3.44	1.48	10.52	12.73	13.25	9.21	5.74
1980-81	17	1383	748.83	1936.73	1641.7	233.93	50.31
Def 1980-81	17	1383	85.62	221.44	187.71	26.75	5.75
2015-16	91	8472	199394	455416	398216	40630	5466
Def 2015-16	103	9488	22798.61	52072.03	45531.81	4645.61	624.98
Overall Growth	5.13	5.5	16.78	16.38	16.48	15.4	13.91

Table 6: Industry group-V manufacture of beverages.

	1980-81	1990-91	2000-01	2010-11	2015-16
Meat industry	1850876	10885492	214428	714012	878728
Meat industry % share (F P I)	33.33	37.98	24.06	25.49	23.02
Meat industry % share (Overall)	7.43	8.721	6.12	4.8	4.74
Dairy industry	660188	3963072	209282	363635	565677
Dairy industry % share (F P I)	11.89	13.83	23.42	12.99	14.82
Dairy industry % share (Overall)	2.65	3.17	5.98	2.45	3.05
Grain, starch industry	2374258	8884078	293900	955372	1558944
Grain, starch industry % share (F P I)	42.75	30.99	32.99	34.12	40.85
Grain, starch industry % share (Overall)	9.53	7.12	8.39	6.43	8.4
Other food products industry	474248	2889192	106336	276825	357656
Other food products industry % share (F P I)	8.54	10.08	11.94	9.89	9.37
Other food products industry % share (Overall)	1.9	2.31	3.03	1.86	1.93
Beverages industry	193673	2037746	66941	490315	455416
Beverages industry % share (F P I)	3.48	7.11	7.51	17.51	11.93
Beverages industry % share (Overall)	0.78	1.63	1.92	3.3	2.45
Total FPI	5553243	28659580	890887	2800159	3816421
Total FPI % share	22.23	22.96	25.44	18.83	20.57
Overall industries	24910451	124810046	3501849	14866258	18552084

Table 7: Market share analysis.

Table 9 presents the Total Factor Productivity (TFP) growth and various efficiencies change for both the pre-and post-reform periods in Punjab. The results indicate that the mean TFP for the Meat and Dairy Industry has decelerated in the post-reform period as compared to pre-reform period. TFP change for Beverages, Grain, Starch, and other food products accelerated during post-reform periods as compared to pre-reforms period. The Technological Change of food processing industries shows a positive trend during pre-reform period as compared to post-reform period. Scale Efficiency Change of Meat and Beverages Industry accelerated during post-reform period as compared to prereform period. Technical Efficiency Change of various food processing industries shows more growth in post-reform period as compared to pre-reform period. The average annual growth rates of Total Factor Productivity (TFP), Technical Efficiency and various efficiencies change in the period from 1998-99 to 2015-16 over the period from 1980-81 to 1997-98 for all Five different food processing industries are presented in Table 10. The results exhibit that the TFP growth in 2 out of 5 industries shows negative growth in the period from 1998-99 to 2013-14 as compared to the period from 1980-81 to 1997-98. There are only three industries, *viz.*, beverages, food, starch, and other food products, where the productivity growth is positive during 1998-99 to 2013-14. The two major industries, meat and dairy products also show a negative productivity growth during 1998- 99 to 2013-14 over the previous periods.

It is interesting to find a positive change in technical and scale

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Industry	Technical efficiency change	Technological change	Pure technical efficiency change	Scale efficiency change	Total factor productivity change
Meat	1.008	1.21	1.001	1.006	1.219
Dairy	0.903	1.162	0.951	0.949	1.049
Grain, Starch	0.873	1.049	0.93	0.939	0.916
Other Food Products	0.873	1.17	0.874	0.999	1.021
Beverages	0.946	1.184	1	0.946	1.12
Mean	0.919	1.154	0.95	0.967	1.06

Table 8: Malmquist index summary of firm means.

			Period			Period					
	1980-81 to 1997-98						199	8-99 to 2015- <sup>,</sup>	16		
Industry	Technical Efficiency Change	Technological Change	Pure Technical Efficiency Change	Scale Efficiency Change	Total Factor Productivity Change	Technical Efficiency Change	Technological Change	Pure Technical Efficiency Change	Scale Efficiency Change	Total Factor Productivity Change	
Meat	0.909	1.72	0.975	0.932	1.563	1	1.099	1	1	1.099	
Dairy	1	2.072	1	1	1.437	0.943	1.005	0.905	1.042	0.948	
Grain, Starch	0.641	1.346	0.684	0.938	0.863	0.874	0.972	1.007	0.868	0.85	
Other Food Products	0.773	1.713	1	0.773	1.324	1.009	1.014	1.012	0.998	1.023	
Beverages	0.896	1.593	0.828	1.082	1.427	0.905	1.083	1.032	0.877	0.979	
Mean	0.834	1.676	0.888	0.939	1.398	0.945	1.034	0.99	0.954	0.976	

Table 9: Total factor productivity change and various efficiency change across the three-digit industries.

efficiency in most industries in the post- reform periods over the pre-reform periods. The overall results suggest that the growth of productivity in the post-reform periods is mostly affected by technical progress.

The following Figures 3 and 4 shows the trends in different change indices from 1980-81 to 2013-14 for different food processing industries of Punjab.

The above figure depicts that there is high growth of Total factor Productivity Change from 1980-81 to 2015-16 which shows that there was an improvement in the efficiency or the production performance as shown by the growth of technical efficiency and technical change indices. The success of the industry to produce in the optimal scale is indicated by the positive growth of scale efficiency change while positivity of pure technical efficiency change depicts the industry has shown remarkable learning process.

The above figure shows that dairy industry shows nearly constant growth in the production. There is a constant growth in the learning process of the industry while there is no change in the scale efficiency change. The total factor productivity change decline slightly from 1980-81 to 2015-16.

Growth Rates in Percentage									
Industry	Technical Efficiency Change	Technological Change	Pure Technical Efficiency Change	Scale Efficiency Change	Total Factor Productivity Change				
Meat	10.01	-36.1	2.56	7.3	-29.69				
Dairy	-5.7	-51.5	-9.5	4.2	-34.03				
Grain, Starch	36.35	-27.79	47.22	-7.46	-1.51				
Other Food Products	30.53	-40.81	1.2	29.11	-22.73				
Beverages	1	-32.02	24.64	-18.95	-31.39				
Mean	13.31	-38.31	11.49	1.6	-30.19				

Table 10: Productivity Growth, TP, and Efficiency Change during 1998-99 to 2015-16 as compared to the period from 1980-81 to 1997-98.





Grain and Starch Industry shows downward and upward trends in the productivity from 1980-81 to 2010-11 attributed to fluctuating growth of total factor productivity change, technical and scale efficiency change whereas there is upward trend in the production from 2010-11 till 2015-16.

Other Foods Products industry shows a zig-zag progress in the efficiency due to sluggish growth of various efficiency change indices. There is a considerable growth in the production from 1990-91 to 1995 96 as indicated by the gradual growth of total factor productivity change, technical and scale efficiency change indices.

## **Beverages industry**

Beverages industry shows considerable growth from 1990-91 to 1995-96 and from 2005-06 to 2010-11 attributed to growth in various efficiencies change indices. Total factor productivity change and scale efficiency change shows high growth from 2000-01 to 2010-11 (Figure 5).

Food Processing Industry shows downward and upward trends in the productivity from 1980-81 to 2010-11 attributed to fluctuating growth of total factor productivity change, pure technical efficiency change and scale efficiency change whereas there is upward trend in the production from 2010-11 till 2015-16 (Figure 6).

Technical Efficiency change occurs very high in Meat Industry and Grain, Starch Industry whereas there is almost constant growth in rest of the industries during the period from 1980-81 to 2015-16 (Figure 7).

Technological change occurs very high in all the food processing industries from 1990-91 to 1995-96 thereafter the growth diminishes. Meat, Dairy, Grain and Starch Industry, Beverages and other food products Industry shows almost constant growth during the period from 1980-81 to 2015-16 (Figure 8).

Pure technical efficiency change shows a rapid growth for Meat and Grain and Starch industry from 1980-81 to 2015-16 whereas rest of the food processing industries shows constant growth (Figure 9).

Scale efficiency change shows a rapid growth for Meat and other food products industry from 1995-96 to 2005-06 whereas rest of the food processing industries shows constant growth (Figure 10).





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Total factor productivity change shows rapid growth from 2001-01 to 2010-11 for other food products industry whereas change growth rises steeply during 2010-11 to 2015-16 for Meat and Grain and Starch Industries respectively (Figure 11).

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