

## TOTAL FACTOR PRODUCTIVITY GROWTH AND PERFORMANCE OF LIVESTOCK SECTOR IN PUNJAB, PAKISTAN

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### ABSTRACT

In this study, total factor productivity (TFP) performance of livestock sub-sector in Punjab, Pakistan was estimated for the time period of 1970 to 2009. The objective was to analyse the effect of government policy changes on livestock sector performance. For this purpose index number approach namely Tornqvist Theil approximation to Divisia index was employed. Results revealed that overall average annual growth rate of livestock TFP index in Punjab remained 1.54 percent. The contribution of TFP towards output growth stood at 42.66 percent during the study period. The output and input growth remained as 3.61 and 2.03 percent, respectively. The results further indicated that productivity growth has been a significant factor in the performance of livestock sub-sector in Punjab over 39 years. The analysis also disclosed that TFP remained negative during no plan period (1970-78) due to neglect of this sector. Then it started increasing and reached to the level of 2.63 with 56.53 percent contribution of TFP towards output growth of the sector. This is the maximum growth of TFP which has been observed during 1983-1988 due to change in government policy in favour of livestock sub-sector.

**KEYWORDS:** Livestock; performance; productivity; Punjab; Pakistan.

### INTRODUCTION

Livestock, a sub-sector of agriculture, is the single largest contributor to overall agricultural growth. This sector grew by 4.1 percent in 2009-10 as against 3.5 percent during the year 2008-09. Livestock plays an important role in the economy of the country. This sector contributed approximately 53.2 percent to agriculture value added and 11.4 percent to national GDP during 2009-10. Gross value addition of livestock at current factor cost has

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increased from Rs. 1304.6 billion (2008-09) to Rs. 1537.5 billion (2009-10) showing an increase of 17.8 percent as compared to previous year.

On an average, farmers derive 30 to 40 percent of their income from the livestock sector, and about 30 to 35 million rural people are engaged in raising livestock (7). According to household income and expenditure survey data (HIES), consumption of livestock products in Punjab increased sharply from late 1980s to mid 1990s which caused very rapid growth of livestock sector during this period (13).

The increase in population growth, per capita income and change in consumption pattern is fueling the demand of livestock and its products in Punjab. There is a need to increase productivity of livestock sub-sector in Pakistan. The most comprehensive measure of aggregate productivity is total factor productivity (TFP). Various studies in the empirical literature had estimated TFP of crops and livestock sub-sectors by employing different approaches. Jin *et al.* (21) found that from 1980-95, China's TFP for rice, wheat, and maize grew rapidly and new technology accounted for most of the productivity growth. Cornejo and Shumway (17) calculated TFP for Mexican agriculture sector and found that TFP grew at an annual rate of 2.8 percent over the period of 1960 to 1990. Gerdin (19) analyzed the pattern of productivity and economic growth in agriculture sector of Kenya between 1964 and 1996 and reported that contribution of productivity growth to output growth increased from 10.2 percent in 1964–1973 to 26.8 percent in 1988–1996. Mukherjee and Kuroda (23) estimated the productivity growth in Indian agriculture for the period 1973-93 and reported that agriculture sector performed admirably after the introduction of modern technology and high yielding "Green Revolution" varieties since late 1960s. However, due to data limitations, this area of research could not be explored extensively in Punjab, Pakistan.

Few studies have been conducted in Pakistan on TFP. Wizarat (27) computed TFP for the period of 1953-54 to 1979 for Pakistan agriculture and concluded that growth of value added index, aggregate input index and TFP index remained 3.4, 2.3 and 1.1, respectively. Rosegrant and Evenson (25) estimated TFP growth for the period 1956-1985 in crop sector and observed maximum growth during green revolution @ 1.86 percent per annum which declined very sharply subsequently. Khan (22) computed TFP for agriculture sector for the period 1960-1996 and reported that TFP grew at an average annual rate of 0.8 percent. Ali and Byerlee (3) estimated TFP for the period 1966 to 1994 using T-T index and concluded that aggregated total factor

productivity increased by 1.51 percent per annum, while TFP for livestock sub-sector was estimated at 1.26 percent. Ali (1) calculated TFP using Tornqvist-Theil index methodology for the period 1960-96 and reported that factor productivity had grown at an average annual rate of 2.3 percent for the entire period. Nadeem (24) estimated TFP in Punjab agriculture sector and concluded that annual average growth rate of input, output and TFP indices remained 1.46, 3.49 and 2.0, respectively for the study period.

In present study total factor productivity of livestock sub-sector in Punjab province was estimated to analyse the performance of livestock sector in different decades and plan periods. Since the resources are changing due to many factors including government policies, there is a need to estimate TFP growth in livestock sub-sector in Punjab for analyzing the effect of policy changes and provision of policy options for judicious allocation of scarce resources in this sector.

## MATERIALS AND METHODS

This study was conducted in two major approaches have been used frequently in literature namely (a) econometric approach and (b) growth accounting (index number). Under growth accounting there are further two commonly used measures i.e. Arithmetic Index (AI) and Tornqvist-Theil Index (TTI). In this study second approach was applied due to its advantages over growth accounting.<sup>1</sup>

The Tornqvist-Theil (T-T) approximation to Divisia index for TFP estimation is implied in this empirical work. The most frequently used formulation of Antle and Capalbo (2) and Thirtle and Bottomley (26) is applied as:

$$\ln(TFP_t/TFP_{t-1}) = \frac{1}{2} \sum_i (R_{it} + R_{it-1}) \ln(Q_{it}/Q_{it-1}) - \frac{1}{2} \sum_j (S_{jt} + S_{jt-1}) \ln(X_{jt}/X_{jt-1}) \quad (1)$$

Here  $R_{it}$  is the share of output  $i$  in total revenue,  $Q_{it}$  is output  $i$ ,  $S_{jt}$  is the share of input  $j$  in total input cost, and  $X_{jt}$  is input  $j$ , all in period  $t$ . In this specification, revenue shares for output index and cost shares for input index are updated every time period as compared to the use of fixed weights in

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<sup>1</sup>For example, T-T index uses a time varying weighting scheme and it has come to be viewed as superior to other indices. T-Theil index is a superlative index which is exact for the linear homogeneous translog production function (9), a further advantage of T-Theil index is that it accounts for changes in quality of inputs because current factor prices are used in constructing the weights, quality improvements in inputs are incorporated, to the extent that these are reflected in higher wage and rental rates (6).

arithmetic and geometric indices. This avoids the underestimation/overestimation, implicit in a fixed-weight estimation procedure.

TFP index is computed with aggregate output and input indices. The gross output index includes beef, mutton and milk products while inputs include labour, fodder, concentrates and wheat straw. The output data on livestock is not readily available in any official statistics. Therefore, it had to be estimated based on the data available at Pakistan level in various issues of Economic Survey (4, 5, 6, 7).

Farm gate prices for all livestock categories were also not readily available. These were estimated from whole sale prices obtained from different official sources including Year Book of Statistics (15), Reports of Punjab Economic Research Institute (8), Economic Survey of Pakistan, etc. by assuming that farm gate prices were uniformly 20 percent lower than the whole sale prices<sup>2</sup>. Data on inputs quantities and their prices were collected or estimated from various sources which include Pakistan Labour Force Survey (10), Pakistan Livestock Census (11), Punjab Development Statistics (17). Extrapolation or Interpolation was also made where found necessary.

## RESULTS AND DISCUSSION

The output and input indices are based on the output and input aggregators as defined in equation 1. The estimated output, input and TFP indices obtained from Tornqvist-Theil indexing procedure are set at 100 for the year 1970-71 (Annexure and Table 1). The data show that the highest average annual growth (2.70%) in total factor productivity occurred during the decade of 1980s. The overall average annual growth rate of TFP in Punjab remained 1.54 percent. The contribution of TFP towards output growth remained 42.66 percent during the whole study period. The output and input growth was calculated as 3.61 and 2.03 percent, respectively. The results also indicate that TFP growth was negative during the decade of 1970s (-0.88) as main emphasis during the decade was on crop sector due to Green Revolution. These results agree to the finding of Mukherjee and Kuroda (23) and Rosegrant and Evenson (25). The data (Table 1) further show that contribution of TFP towards output growth was maximum (56.72%) during 1980s. The main reason was the strengthening of research capabilities of livestock sub-sector under World Bank project. The results also indicate that productivity growth was a significant factor in the performance of livestock sub-sector in Punjab over 39 years.

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<sup>2</sup> The same procedure is also being used by Federal Bureau of Statistics (FBS), when required (12).

**Table 1. Decade-wise average growth rates (%) of livestock output, input and TFP indices in Punjab.**

Period	Output Index	Input Index	TFP Index
1970-80	1.83	2.73	-0.88 (0)
1980-90	4.76	2.01	2.70 (56.72)
1990-2000	3.81	1.90	1.87 (49.08)
2000-2009	3.89	1.31	2.55(65.55)
		Total Period	
1970-2009	3.61	2.03	1.54 (42.66)

Note: Values in parenthesis in the last column are the percent contribution of productivity growth to livestock output growth.

The results obtained for different plan periods (Table 2) show that TFP remained negative during 1970-78 (-0.44), no plan period. Main reason for negative TFP growth was the neglect of this sector, so total stock of matured cattle and buffaloes grew at an average rate of only 1.82 percent during the decade. During the period major focus of the government was on crop sector and policies pursued were designed to promote crop production which hampered the livestock production (10). These findings are in agreement to those of Jin *et al.* (21), Ali (1) and Khan (22).

**Table 2. Average growth rates (%) of livestock output, input and TFP indices in different plan periods.**

Plan period	Output Index	Input Index	TFP Index
1970-78	2.05	2.50	-0.44 (0)
1978-83	2.15	1.22	0.92 (42.93)
1983-88	4.66	1.97	2.63 (56.53)
1988-93	4.08	2.48	1.57(38.37)
1993-98	3.38	3.01	0.36(10.66)
1998-2009	3.14	0.76	2.37(99.71)

Note: Values in parenthesis in the last column are the percent contribution of productivity growth to livestock output growth.

However, the situation improved during fifth plan period (1978-83) despite of the fact that funds allocated to livestock sub-sector were only 8 percent of those provided to agriculture sector. One of the major reasons for improvement, was the start of World Bank project wherein research capabilities were strengthened both at federal and provincial levels. Pakistan Agricultural Research Council was also established under the project. The encouraging results were obtained during sixth plan period (1983-88), where TFP growth of livestock sector was maximum (56.53%). Reasons behind the encouraging growth was the outcome of World Bank project and the establishment of NARC in 1984 to conduct research on crops, natural resources, livestock, socioeconomics and agricultural production resources.

Moreover, research capabilities in crop and livestock sectors were strengthened under the World Bank project (ARP-1).

During seventh five year plan (1988-93) TFP again declined and it became 1.57 (38.37%). TFP decreased substantially to 0.36 during 8<sup>th</sup> five year plan (1993-98) due to severe drought in second half of the 1990s which inflicted a colossal loss to both crops and livestock sectors (20). The data (Table 2) show that TFP growth rate was again encouraging during 1998-2009 (2.37%). This increase in TFP was the result of government initiative to increase productivity of livestock sub-sector. The government constituted a Livestock and Dairy Development Board to promote production of this sector and export of its products. The board provides technical help and guidance to all stakeholders engaged in dairy and livestock business at small level. According to livestock census 2006, the share of livestock in agriculture growth jumped from 25.3 percent in 1996 to 49.6 percent in 2006. The higher growth in livestock sector has been mainly attributed to the growth of headcount of livestock and milk production. The milk production increased by 36 percent since 1996 to 2006 (10) which encouraged the private sector. Islamabad Milk plant was made operational through a joint venture with Idara-e-Kisan. Livestock nutrition was improved through sowing of improved varieties of fodder seeds like Sadabahar and Mott grass having higher per acre yield and better fodder efficiency. Silage/hay making techniques and use of molasses blocks for fattening of animals were encouraged (4). Moreover, National Veterinary Laboratory was established. Imported plants and equipments were exempted from sales tax. Import of breeding stock was allowed and credit facility was enhanced to promote livestock sub-sector in the country during study period (5).

### **CONCLUSION AND RECOMMENDATIONS**

Overall average annual growth rate of TFP in Punjab remained 1.54 percent. The contribution of TFP towards output growth remained 42.66 percent during the whole study period (1970 to 2009). The results also indicate that TFP growth was negative during the decade of 1970s as main emphasis during this period was on crop sector due to Green Revolution. The output and input growth remained as 3.61 and 2.03 percent, respectively. The productivity growth has been a significant factor in the performance of the livestock sub-sector in Punjab over 39 years. The analysis during different plans period reveals that TFP remained negative during no plan period (1970-78) due to neglect of this sector. Then it started increasing and reached to the level of 2.63 percent with maximum contribution of TFP (56.53%) towards output growth of the sector during 1983-88. Main reason

for this TFP contribution was the change in government policy in favour of livestock sub-sector.

Livestock sub-sector contributes approximately 53.2 percent of agriculture value added and 11.4 percent to national GDP. Therefore, policies should be devised to increase the productivity of this sub-sector. Thus first priority should be to increase the technical efficiency of this sector through educating the farmers in terms of better livestock management practices. However, our focus should not be diverted from technological change as it constituted maximum part of TFP and is a major tool for rapid increase in livestock productivity to meet 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.

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Annexure

Indices of Agricultural Output, Input, and TFP in Punjab

Year	Output Index	Input Index	TFP Index
1970	100	100	100
1971	105.17	108.74	96.72
1972	103.58	104.95	98.70
1973	104.27	108.52	96.08
1974	106.08	110.02	96.42
1975	106.07	111.56	95.08
1976	106.77	116.82	91.40
1977	113.64	116.95	97.17
1978	116.91	120.91	96.70
1979	119.92	127.94	93.72
1980	119.90	130.96	91.55
1981	124.20	134.6	92.28
1982	127.56	137.95	92.47
1983	133.36	135.92	98.12
1984	139.69	135.83	102.84
1985	144.80	147.52	98.15
1986	155.39	141.61	109.73
1987	166.14	150.57	110.34
1988	175.42	149.77	117.12
1989	182.52	157.33	116.02
1990	190.87	159.78	119.46
1991	193.56	170.00	113.86
1992	212.20	167.04	127.04
1993	222.96	177.80	125.4
1994	234.8	171.96	136.55
1995	271.33	173.64	156.26
1996	240.36	174.02	138.12
1997	267.01	200.15	133.41
1998	277.29	199.44	139.03
1999	287.45	204.23	140.75
2000	277.31	192.85	143.79
2001	322.95	183.41	176.08
2002	319.11	189.49	184.10
2003	334.04	193.75	172.41
2004	346.65	201.50	172.03
2005	355.37	204.36	173.90
2006	363.34	207.68	174.96
2007	372.58	211.07	176.52
2008	381.81	209.46	182.29
2009	391.05	216.85	180.33