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Full Length Research Paper

Comparative economics of crop and livestock enterprises in various provinces of Pakistan in the temporal context

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The TFP for crops in Punjab and Sindh stood at about 1% per annum, while that for KP was 0.36% and livestock TFP in KP was noted to be highest of all, which may be due to KP's scarcity of land requiring heavy reliance on livestock. The producers in Balochistan achieved the highest TFP growth rate of more than 5% per annum for crops, which may be attributed to additional canal water provided to Balochistan in 1990.

Keywords: Crop and livestock, productivity, Provinces, TFP.

INTRODUCTION

The agricultural sector in Pakistan's four provinces, namely Punjab, Sindh, Khyber Pakhtunkhwa (KP) and Balochistan is mainly comprised of crop and livestock activities. Growth in inputs, outputs and Total Factor Productivity (TFP) in both of them is of vital significance for the planners and policy makers (Govt. of Pakistan, 2009a, 2009b, 2010a and 2011). The development of Pakistan's crop sector initiated in 1960s with the introduction of green revolution technologies, which comprised of bio-chemical, mechanical and hydrological inputs. The other changes comprised replacement of bullock farming with mechanical cultivation, reduction in arable land per capita and emergence of the livestock activities as a major source of livelihood and its contribution to agriculture's value added in GDP increased from 28% in 1980-81 to 55% in 2011-12 (Govt. of Pakistan, 1981 and 2012b).

In Ellahi *et al.* (2010 and 2012) studies on TFP for crops (1980-81 to 2005-06) and livestock (1980-81 to 2008-09), it transpired that TFP for the former was higher than the latter. Both these activities are subject to natural hazards, but growth in livestock industries is considered to be relatively more stable, impressive and sustainable as compared with crops (Govt. of Pakistan, 2010). However, evidences (Ellahi *et al.*, 2010 and 2012) exist that the varying resource endowments across the country lead to uneven distribution in growth of input-output use levels and TFP for crop and livestock across the four provinces, requiring TFP estimates to assist the planning machinery for undertaking an integrated development plan for the overall agricultural sector. Further, crop and livestock enterprises are complementary to each other as fodders and crop byproducts, such as straw from wheat, rice and gram and sugarcane tops are used as feed for livestock. Therefore, the growth process needs to be studied in the light of empirical results and other factors operating in the overall economy.

Most spatio-temporal studies of TFP growth in Pakistan related to crops. Examples are Ellahi (2007), Ellahi *et al.* (2009a, 2009b and 2010), Ali (2000 and 2005), Murgai, *et al.* (2001), Khan (1994 and 1997), Ali and Velasco (1994), Rosegrant and Evenson (1993),

Azam, *et al.* (1991) and Wizarat (1981). A similar study was carried out by Ellahi *et al.* (2012) for the fast-growing livestock sector.

MATERIALS AND METHODS

Method of Analysis

Several methods have been used to measure TFP in Pakistan. They include non-parametric linear programming (Ellahi, 2007; Ellahi *et al.,* 2009a, 2009b; Wizarat, 1981), index number methods (Azam *et al.*, 1991, Ellahi, 2007, Ellahi *et al.,* 2009a, 2009b, 2010 and 2012, Rosegrant and Evenson, 1993; Khan, 1997; Ho and Arif, 2004; Ellahi, 2007), and stochastic frontier analysis (Ahmad, 2003). The spatio-temporal input-output and TFP analysis of crop and livestock production in Pakistan is carried out for 30 years from 1980-81 to 2009-10.

Index Method

The Divisia input-output and chain-linked Törnqvist TFP index (Törnqvist, 1936 in Coelli *et al*., 2005) was selected to measure the variables of interest for crop and livestock industries. This method was used in most previous studies of TFP growth and requires the aggregation of inputs and outputs into single indices using weights based on cost and revenue shares, respectively. In order to define the Törnqvist index, the input-output quantities and their respective shares in the total cost and total revenue, respectively, need to be defined. The rationale for selection of the Törnqvist TFP index is provided by Ellahi *et al.* (2010).

Coelli *et al*. (2005) defined the Törnqvist output quantity index in multiplicative form as:

$$Q_{st}^{T} = \prod_{m=1}^{M}\left[\frac{q_{mt}}{q_{ms}}\right]^{\frac{\omega_{ms}+\omega_{mt}}{2}} \qquad (1)$$

where q_{ms} is the *m*-th output quantity in the base period, *s*, q_{mt} is the *m*-th output quantity in the current period *t*, and ω_{ms} and ω_{mt} are the revenue shares of output *m* in periods *s* and *t*, respectively. Following a similar procedure, Coelli et *al*. (2005) defined the Törnqvist input quantity index in its multiplicative form as:

$$\prod_{n=1}^{N}\left[\frac{x_{nt}}{x_{ns}}\right]^{(\omega_{nt}+\omega_{ns})/2} \qquad (2)$$

where x_{ns} is the *n*-th input quantity in the base period, *s*, x_{nt} is the *n*-th input quantity in the current period, *t*, and ω_{ns} and ω_{nt} are the cost shares of input *n* in periods *s* and *t*, respectively. The average annual change in the Törnqvist TFP index was measured using these output and input quantity indices and following the standard procedure as detailed, for example, by Murgai *et al*. (2001).

Following the methodology adopted by Ho and Ariff (2004), each of the four provinces purchase quantities, $x_1, x_2, \ldots, x_n$ at prices $p_{x1}, p_{x2}, \ldots, p_{xn,}$ respectively. The total cost of these inputs is $p_{x1}x_1 + p_{x2}x_2 +, \ldots, + p_{xn}x_n = C$ and $w_{xi} = p_{xi}\, x_i/C$ is the share of *i*th input in C over the time period *t*. Given this specification, the Divisia index for inputs is defined as:

$$\ln(X_t/X_{t-1}) = \sum_{i=1}^{n} \bar{w}_{xi} \ln(x_{it}/x_{it-1}) \qquad (3)$$

where $w_{xi} = (w_{xit} + w_{xi,t-1})/2$, which is an arithmetic average of w_{xit} in periods *t*-1 and *t*. Likewise farmers in all provinces produce output quantities, $y_1, y_2, \ldots, y_m$ which are sold at prices $p_{y1}, p_{y2}, \ldots, p_{ym,}$ respectively, and w_{yj} represents the revenue share of the *j*th output. Thus, the Divisia index for outputs is defined as:

$$\ln(Y_t/Y_{t-1}) = \sum_{j=1}^{m} \bar{w}_{yj} \ln(y_{jt}/y_{jt-1}) \qquad (4)$$

The left hand side (LHS) defined in equations (3) and (4) are appropriately weighted means of log-changes in the inputs and outputs. These are the respective rates of annual change for inputs and outputs in years 2 to 30, while that for year 1 is treated as zero. The LHSs, after appropriate transformations, may be converted into the series of input and output indices having 1 for year 1. Subtracting LHS of equation (3) from that of equation (4) gives relationship of TFP with inputs and outputs used in the production process.

Data Compilation

The requisite data for crops and fruits were collected by Ellahi (2007) and Ellahi *et al.* (2010) for 26 years (1980-81 to 2005-06). These data were extended for another 4 years, i.e. up to 2009-10 and some other crops, such as sorghum, millet, barley and green fodders were included, while on the input side bullock draught power was added to data on fertilizer, irrigation, plant protection and labour used in Ellahi *et al.* (2010). The data series on livestock (Ellahi *et al*., 2012) were extended accordingly so that input-output and TFP analysis may be undertaken consistently for the period considered in this study.

Aggregate data for crops and livestock were collected on prices and quantities of crops (wheat, rice (coarse and fine), sugarcane, cotton, maize, sorghum, millets, barley, fodders, potato, onions, gram, pulses, special oilseeds, sugar beet, tobacco, almonds, apricots, bananas, citrus, dates, guava and mango), milk, draught power, beef, mutton, poultry meat, eggs, hides, skins and wool, and on the inputs used in the production of crop and livestock outputs. Annual input-output data and those for market prices for both crop and livestock at the country level are

Table 1. Province-wise annual rates of change in TFP

Province Activity	Punjab % p.a.	Sindh % p.a.	KP % p.a.	Balochistan % p.a.
Crops	0.94	0.92	0.36	5.48
Livestock	0.86	0.64	0.88	0.82

available in the *Pakistan Economic Survey* (Govt. of Pakistan, 2012b), the *Agriculture Statistics of Pakistan* (Govt. of Pakistan, 2012a), the *Pakistan Statistical Year Book* (Govt. of Pakistan, 2010c) and the *Monthly Statistical Bulletin* (Govt. of Pakistan, 2010b). The marketing of sugarcane, sugar beet and special oilseeds is institutionally carried out by the sugar industry and Ghee Corporation, respectively. Therefore, market prices are not available and support/ indicative prices announced by the government were used. The support prices for sugar beet and special oilseeds were discontinued in 1990-91 and 1999-2000, respectively. The former is exclusively grown in KP and extension in its prices was based on those for sugarcane and the same for the latter were extended on the basis of past trend.

The national data on livestock were apportioned into provinces using the ratios of different types of stock obtained from data provided in the *Livestock Censuses of 1976, 1986, 1996 and 2006* (Govt. of Pakistan, 1978, 1988, 1998 and 2008). Data on inputs include milk for off-springs, green fodders, crop byproducts, concentrates, manufactured feeds, grains and a variety of feeds for poultry, animal health care, medical treatment and human labour used for livestock activities. Several crop byproducts are used for feed in livestock industries, i.e. straw from wheat, rice and gram, stalks from maize, millets and sorghum and tops from sugarcane. Their annual values in current prices are provided in the *Agriculture Statistics of Pakistan* (Govt. of Pakistan, 2012a) for country as a whole. The provincial apportionment was undertaken in accordance with spatial share in total value of the main output.

The basic sources of data on the agricultural labour are the *Population Censuses of Pakistan 1981 and 1998* (Govt. of Pakistan, 1984 and 2002) and the annual series of the *Labour Force Surveys* (Govt. of Pakistan, 2010d). These data, published in the Pakistan *Economic Survey* (Govt. of Pakistan, 2012b), are for the country as a whole and relate to crops and livestock. Annual farm wages for casual labour used in the agriculture sector and wages for unskilled labour in the metropolitan areas are available in the *Monthly Statistical Bulletin* (Govt. of Pakistan, 2010b) and in the *Pakistan Economic Survey* (Govt. of Pakistan, 2012b), respectively. Various issues regarding farm labour and wages thereof, for the period 1980-81 to 2005-06, are discussed by Ellahi (2007), whose method was followed to obtain and extend labour used for crops and livestock and wages thereof.

A moving average of the crop and livestock output variables need to be used to reduce the exaggerated effects of drought, floods and good seasons on crop output and for ample fodders and free of epidemics. These factors do not operate at a regular interval. However, a period of two years was considered appropriate to smooth out fluctuations in the TFP for crops and livestock.

RESULTS AND DISCUSSION

Estimates of TFP Change

The province-wise empirical results of average annual growth rates in TFP for crops and livestock using Törnqvist indices are presented in Table 1. Indices are also depicted graphically for Punjab, Sindh and KP in Figure 1. The trend in TFP for all provinces along with Balochistan is portrayed separately in Figure 2 because its production pattern, especially that of crops (Ellahi *et al.* 2010), was substantially different from rest of provinces over the study period. As seen from Table 1, Balochistan's TFP change per annum, for crops is about five times higher than that for the rest all provinces.

The results depicted in Figure 1 exhibit that the growth rate in TFP for crops in Punjab and Sindh was almost the same and stood at about 1% per annum, while that for KP stood at 0.36%. The observation about KP may be related to scarcity of land, which leads to a great deal of reliance on livestock (Figure 1). It may further be noted from A. Figure 1 that Divisia indices for crops are fairly stable, while a great deal of variation (upward) is noted for livestock in KP. It is, however, clear that livestock's edge over crops in terms of TFP (outputs less inputs) is prominent. The producers in Balochistan achieved the highest TFP growth rate of more than 5% per annum, which may be attributed to additional canal water provided to Balochistan in the beginning of 1990s (Abbasi *et al.*, 2000), which gave a boost to crop output (Ellahi, 2007).

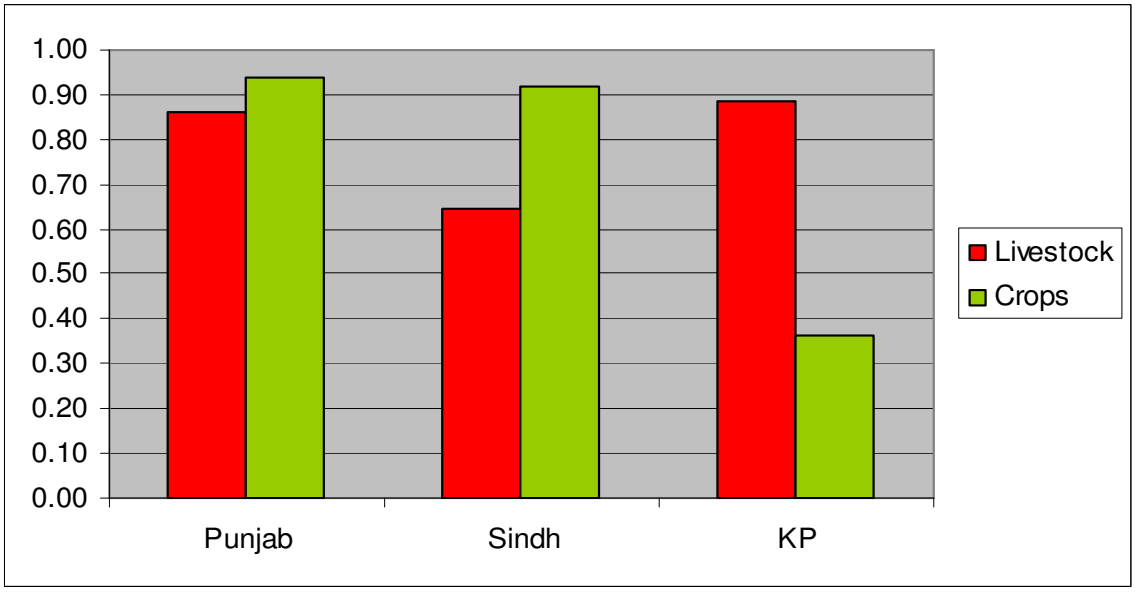


Figure 1. Annual TFP Indices in Punjab, Sindh and KP, 1980-81 – 2009-10 (1980-81 = 100) for Crop and Livestock Activities.

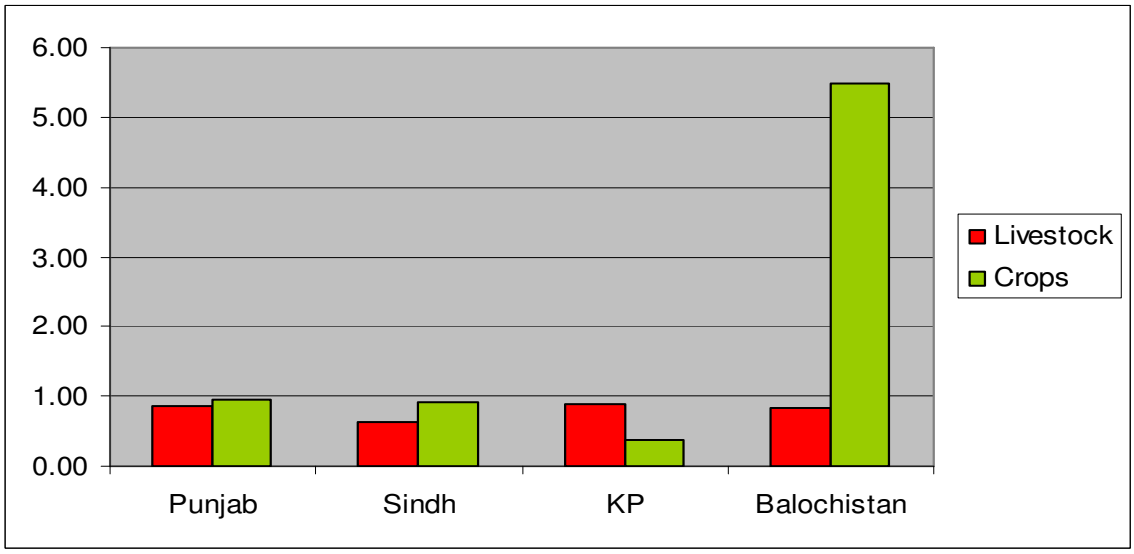
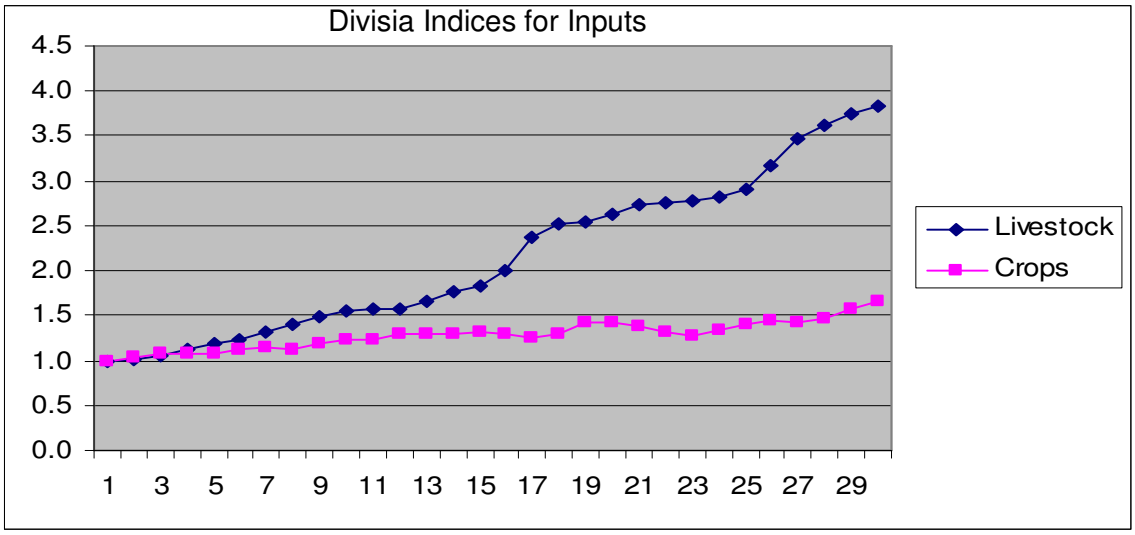


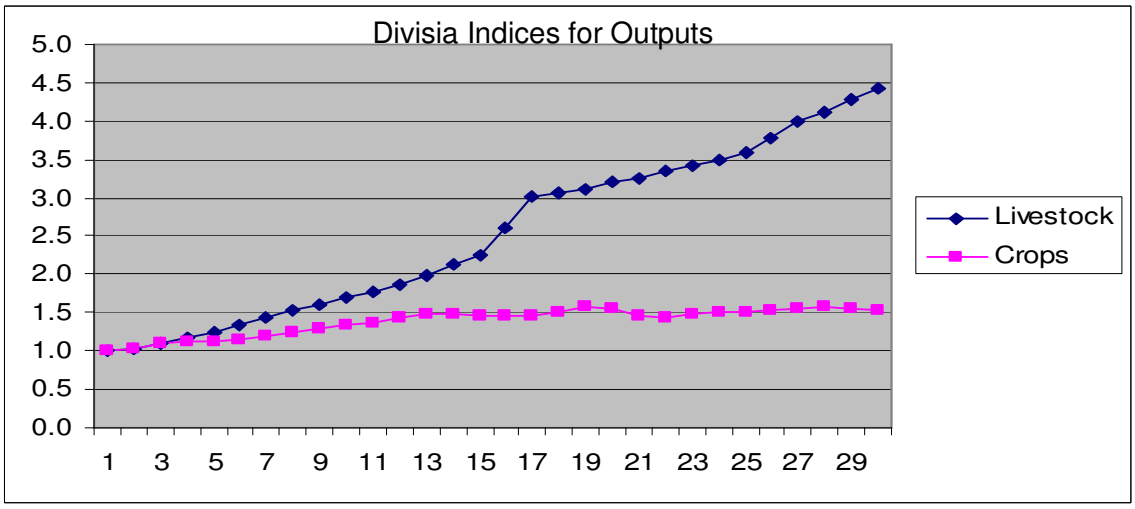
Figure 2. Annual TFP Indices in all provinces, 1980-81 – 2009-10 (1980-81 = 100) for Crop and Livestock Activities.

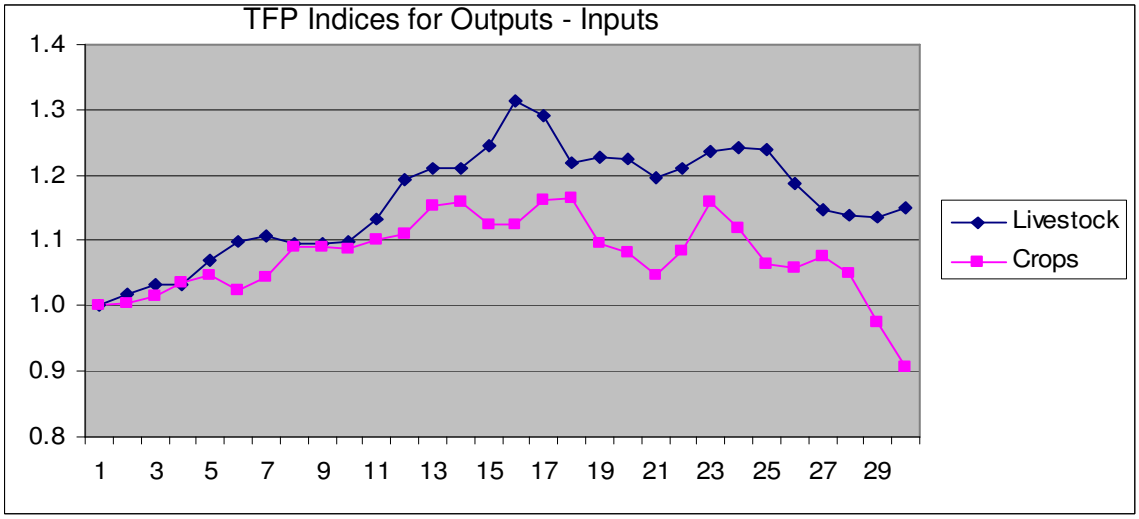
CONCLUSION

There are two salient observations, viz. growth rate in TFP for crops in Punjab and Sindh stood at about 1% per annum, while that for KP was 0.36% and livestock TFP for KP was noted to be highest of all. These observations about KP may be due to scarcity of land, which leads to a great deal of reliance on livestock. The producers in Balochistan achieved the highest TFP growth rate of more than 5% per annum for crops, which may be attributed to additional canal water provided to Balochistan in 1990, which gave a boost to crop output.

A. Figure 1
TFP Indices for Inputs, Outputs and Net of Both for Crops and Livestock in KP







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