TECHNOLOGICAL PROGRESS IN AGRICULTURAL SECTOR OF PAKISTAN

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ABSTRACT

Technological progress has played an important role to identify the demand of agro food in different decades. Total factor productivity index is used as proxy for the technological progress. The data consisted of output and input variables for the technological progress has been taken from the year of 1961-2013 from different sources. The tremendous growth in the TFP has been observed during the decade of 60’s and lowest rates during the decade of 70s and in 2000. The results realized those factors which affected the productivity in different decades. Increase in inputs is not only the cause of favourable production, but the main thing is to efficiently utilize those resources. TFP index showed that in 60’s when government implement strategies effectively it increased the TFP rate. The results significantly proved that technological progress in different decades has highly affected the growth rates in agricultural sector.

Keywords: Tornqvist-theil (T-T) index, technological progress, output variables and input variables.
INTRODUCTION

Technological progress has played an important role in every sector. The production function tells us that three elements can only boost our output growth rate and these three elements are increase in capital stock, increase in employment and technological progress. But the economist explained that increase in capital stock and increase in employment has some limitation on the production while the technological progress is the only element which increases the production without any limitations.

Comin and Philippon (2006) explained that technological progress is the share of output which is explained by the amount of inputs used in production. Therefore, technological progress has good impact on the total output growth rate. In 1956 Solow presented the neo classical growth theory. In this theory he calculated a new variable called total factor productivity. This variable was helpful in measuring the technological progress in the economy. This variable was calculated with a few assumptions first when there is impeccable competition in factor market. Second is Production function should be neoclassical and third when inputs are measured accurately.

Current study has used total factor productivity (TFP) as a proxy for measuring technological progress in agricultural sector of Pakistan (Mueller, 1998., Crafts, 2003,, Jajri, 2007,Akanbi, 2011). The, Ekbom(1998), Khan(2006), Ali, Mushtaq et al.(2012) predicted that technological progress captures all the physical factors which increase the productivity of the output including human capital, vintage capital, development expenditures, economies of scale, government policies, international trade policies, remittances, migration and increase in population (it effected labor input), fluctuations in national savings rates (this influences investment and the growth of capital input), openness of the economy to foreign speculation, labor force development through educations and trainings, domestic business aptitude. The role of government in facilitating competition and the development of efficient markets,
materials (M), physical capital investment (K), and physical resource endowment, macro-
economic stability, human sector development, financial sector development, Infrastructural
development, credit resources in agriculture, real per capita income and research and
development.

In 21st century the agriculture sector of Pakistan is’ facing a great challenge in terms of
food sanctuary and endurance in the globalized world under the world trade organization
scenario. But these challenges will be overcome by the improvement in technology in the
agriculture sector. This will ultimately reduce poverty in rural areas and will fulfil food
demands(Chaudhry, 2009). The demand for food is increasing due to low per capita income.
An absence of suitable policy for sustaining the technological progress will impose a high
growth in imports of vital food items. This will increase financial burden directly on foreign
exchange income of a country(Zaidi, 1999)

The current study aims to highlight the growth in technological progress (TFP) in
agricultural sector of Pakistan. The reason for this study is that 50% of Pakistan’s economy
depends on agriculture sector, while this sector has faced many challenges in 21
century(Chaudhry, 2009). To overcome those problems, it needs more empirical studies to
elaborate the main factors of productivity growth.

RESEARCH STATEMENT

Pakistan is a developing country and its economy is not stable, so the study of
technological progress (TFPG) has become very essential with time. Many studies related to
total factor productivity have been conducted on the whole economy and specifically on the
manufacturing sector like Khan(2006), Raheman, Afza et al.(2008), Chaudhry(2009), Usman,
Hassan et al.(2014), however, the agriculture sector remains relatively ignored. Few studies
have considered the agriculture sector See for example, Ali and Iqbal(2004), Kiani(2008), Ali,
Mushtaq et al. (2012), however these studies do not consider all subsectors of agriculture in
Pakistan. Therefore, the present study has considered all the four subsectors (forest, fisheries, crops and livestock) of agriculture in Pakistan. Thus, this topic needs up to date empirical study in order to provide a clear picture to the government agencies by the trend analysis of agriculture input and output ratios and highlight the main sources of productivity growth.

OBJECTIVES OF THE STUDY

The main aim of the current study is:

a) To find the technological progress on the bases of four agriculture sectors

b) To investigate trend analysis by comparing output and input variables by Tornqvist-tail index

c) Results of the study will be analysed on the bases of five-year plan in Pakistan

LITERATURE REVIEW

Many studies have been accompanied on the technological progress (total factor productivity growth) across different economies and in this section few of them are presented below.

Before 1957 there was a great debate on the two questions. First question stated that how far the economic progress is achieved by the development in human capital (labour) and by the growth in other physical factors. While, second question stated, how much growth in economic has been stimulated by the institutional and technological change. In the view of economist, it is a fact that physical and labour capital has significant influence on the economic growth. But, most of the studies showed that persistent high growth is based on the constant institutional and technological change (Bhatia, 1990). In economics one of the assumptions of growth is constant return to scale and competitive factor arcades which calculates the progress rate by considering only the variation in human capital and physical factor. It results the abnormalities of the real growth rate from the implicit growth rate. These
abnormalities are known as total factor productivity growths which are resulted from the institutional and technological change (Mueller, 1998). Solow (1957) derived equation from the Cobb Douglas function and called it Solow residual function. Solow residual function has been used in many literatures for calculating the Total factor productivity.

The debate on technological progress has been started by the Abramovitz (1956), and Solow (1957). Kendrick and Sato (1963) and Kendrick (1973) has worked on the technological progress for the U.S agriculture during 1966 era in which he analysed that productivity is increased from 36.6% to 70.6%. In his work he pointed out that the increased in Technological change is caused by the education, innovation, R&D (research and development), medical care, economic efficiencies and as well as fluctuation in economies of scale, and the quality of human and other material factors of production. Abramowitz (1956) and Solow (1957) have also worked on the technological progress, therefore Kendrick and Sato (1963) and Kendrick (1973) work was aligned with their work. Their work showed that in economic growth the technological growth played a good role.

On the contrary Jorgenson and Griliches (1997) has followed the work of Solow (1957) and debated the unexplained residual which the Solow called the technical change. In his work he made a hypotheses stating that unexplained residual is due to measurement errors or due to the fluctuations in scale of economies and quality of inputs. His work pointed out that Solow and his pioneers only include conventional inputs and did not mention the unconventional inputs which may be the causes of the unexplained residual so he included research and extension and education as a non-conventional input and his results showed that non-conventional inputs reduced the size of the Solow residual.

Wizarat (1981) has also followed the work of Abramovitz (1956), Solow (1957) and Jorgenson and Griliches (1997) and she concluded her results on the source of the empirical study. This study revealed that 84 percent improvement in the productivity is
attributed toward the technological progress while the remaining 16 percent is towards the increase in total input. She conducted her study from the period 1953 till 1979 and used growth accounting model in her analysis. So the results of her study are also aligned with the study of the Solow (1957).

On the source of the growth accounting approach, Khan (2006) has also worked on the total factor productivity in Pakistan and his results shows that yes total factor productivity can explain technological change during the different periods in one country and provide strong results to the study of Solow. Furthermore, Khan’s methodology has been followed by the Akanbi (2011). He conducted research in the Nigeria for finding the technological progress. His results also showed that unexplained residual is actually due to the technological progress.

According to the growth accounting approach (Abramovitz, 1956., Solow, 1957., Wizarat, 1981., Akanbi, 2011) the technological progress (total factor productivity) is calculated as follows.

$$\text{TFP} = \text{total outputs minus total inputs.}$$

So the above equation showed that input and output are the elements of Total Factor productivity. The most dominant inputs are the land, labor and capital (Abramovitz, 1956., Solow, 1957., Wizarat, 1981., Azam, Bloom et al., 1991., Khan, 2006). Fertile land is the main factor in the agricultural productivity, Khan and Salam (1997) has empirically analysed that both technical and structural factors in land are important. Technical factor consist of the quality inputs like fertilizers, pesticides and the availability of good infrastructure, while structural factors includes the efficient use and ownership of land, access to water and other macroeconomics determinants. There are two types of land one is cultivated and other one is cropped land. We can use either one or another, but actually Christensen (1975) used cropped land. On the other hand, cropped land increases with the augmented technological change. It

According to Abramovitz (1956) and Solow (1957) TFPG could not be calculated without labour input and capital. Labour inputs can be calculated by different ways. It can be measured by multiplying the number of labours with annual work days. The standard annual work days in India are estimated as 244 and 215 days and in Pakistan the standard annual work days are estimated as 250 days (Khan and Salam, 1997., Evenson, Pray et al., 1999).

Wizarat (1981) followed the work of Solow (1957) therefore she calculated labour simply by multiplying the number of labours with the agricultural wage rate. While Khan (2006) explained in his paper that we can calculate labour work quality by using the increasing number of employees or training schools, but due to complexities in data, he then followed Fan (1997) and measured labour input. In this procedure he simply took the number of labours per year in Pakistan. Akanbi (2011) had simply calculated it by multiplying Labour Force Participation Rate (LFPR) with total labour force.

Ali and Iqbal (2004) calculated labour input by multiplying the number of participated labours with the annual work days and also used wage rate. Ali, Mushtaq et al. (2008) followed the same procedure in his study for his analysis. All the above methods are accurate. Every author preferred the data availability in their conducted studies.

Capital inputs are important factors in calculating TFPG in both developed and underdeveloped countries. Capital inputs include tractors, tube wells, threshers, fertilizers, pesticides and draught animals’ etc. Wizarat (1981) had worked on Pakistan’s agricultural
productivity in which she used public and private tractors, tube wells and draught animals for calculating the capital input index.

Wen (1993) has worked on China’s agricultural productivity in which he used only draught animals and tractors. Dholakia and Dholakia (1993) has studied Indian agricultural productivity in which he composed capital index with the farm tools and equipment, tractors, threshers, tube wells, farm houses and draught animals. Kumar, Mittal et al. (2008) has followed the inputs of Dholakia and Dholakia (1993) but he worked on south Asian agricultural productivity growth in which he used farm machinery, irrigation tools, pesticides, fertilizers, draught animals for calculating the capital index.

Nadeem, Javed et al. (2010) has worked on Punjab’s agricultural productivity in which he used diesel, tractors, electric tube wells, pesticides, fertilizers and draught animals. Khan and Salam (1997) has also followed Dholakia and Dholakia (1993) and in the same way Ali and Iqbal (2004) has also used tractors, tube wells, working animals, pesticides and fertilizer for the computation of capital index. In the above debate all authors did not used the same inputs for the calculation of capitals in agriculture which concludes that each author has used capital inputs on the bases of data availability.

From the above literature, it is observed that many studies have been accompanied on the total factor productivity growth but because of modest economic growth there are still gaps to contribute in literature. Therefore, the current study is conducted on the gross technological progress by including all sub sectors of agriculture for the analysis in order to know the macro determinants of the technological growth in each sub sector and to provide the essential results to the public and government of Pakistan.

RESEARCH METHODOLOGY

POPULATION AND SAMPLE OF THE STUDY
Population of the current study covers all sectors of Pakistan. The sample of this study comprises of all sub sectors of agriculture in Pakistan like crop, livestock, forest and fishing etc.

DATA COLLECTION AND SOURCES

The current study has used the secondary data. The examination of technological progress in each sub-sector is perplexing because of data restrictions but an effort has been made to acquire a reliable dataset. The data have been collected from 1961-2013 from different sources including the Agricultural Statistics of Pakistan issued by Pakistan Bureau of Statistics (PBS), Labor Force Surveys of Pakistan issued by PBS, the Economic Surveys of Pakistan issued by Ministry of finance and world development indicator (WDI).

VARIABLES OF THE STUDY

There are four types of indices for measuring total factor productivity growth including: The Paasche index, Laspeyres index, Fisher Quantity index, and Tornqvist-Theil (T-T) index.

All indexes have their own uses but present study used Tornqvist-Theil (T-T) index. T-T index has many advantages over the above mention indexes. The first importance of this index is that no limits have been imposing on the replacement possibilities among the inputs. It mean that fever limits have between the TFP and data(Alaston, Norton et al., 1995). Second importance of this index is that it is precise for the linear homogeneous Trans log production function. Third and very important point of this index is that it incorporated the current factor prices for measuring the individual share of the factors and therefore it has been helpful in finding variation in the quality of inputs and outputs. This index has provided constant collection of input and output under the assumption of constant return to scale, competitive factor arcade, output-input reparability and Hicks-neutral technical change(Christensen, Cummings et al., 1981., Antle and Capalbo, 1988). This index have been
Technological progress is the dependent variable and Total factor productivity (TFP) index has been used as a proxy for the dependent variable. TFP consist of all inputs and outputs which are explained below in detail. The proxy for the technological progress is TFP (Hayami, Ruttan et al., 1978., Crafts, 2003., Jajri, 2007., Akanbi, 2011) which is calculated by the Tornqvist-Theil (T-T) index (Fan 1997, Ali, Mushtaq et al., 2008). The Tornqvist-Theil (T-T) index is defined as

\[
\ln \left( \frac{TFP_t}{TFP_{t-1}} \right) = \frac{1}{2} \sum (R_{kt}+R_{kt-1}) \ln \left( \frac{Q_{kt}}{Q_{kt-1}} \right) - \frac{1}{2} \sum (S_{it}+S_{it-1}) \ln \left( \frac{X_{it}}{X_{it-1}} \right) \ldots (1)
\]

Where:

- \( R_{kt} \) is the share of k output in total revenue.
- \( Q_{kt} \) is output k.
- \( S_{it} \) is the share of input i in total input cost.
- \( X_{it} \) is input i.

In this specification, revenue shares for the output index and cost shares for the input index are updated every year. Specifying the index equal to 100 in the base year and accumulating the measures based on equation (1) provides the TFP index (Ali et al., 2008).

**OUTPUT AND INPUT VARIABLES**

TFP consist of the output and input index. In present study output index consist of all sub-sectors of agriculture sector including crops, livestock, forest and fisheries.

**OUTPUT INDEX DATA**
Output series for the crops are Wheat, rice, bajra, jowar, maize, barley, gram, masoor, mash, mong, matter, potatoes, tomatoes, onions, sugar cane, tobacco, cotton, chilies and fruits. Prices data were collected from the Pakistan statistical yearbooks (2013, 2007, 1980, 1976, 1975, and 1968) while production data were obtained from agricultural statistics of Pakistan (2011-2012, 1947-1997) and economic survey of Pakistan(2013).

Output data series for the livestock are Milk, beef, mutton, eggs production, wool, hides and skin. The production data were collected from the economic survey of Pakistan 2013 while prices data were obtained from the Pakistan statistical yearbooks (2013, 2007, 1980, 1976, 1975, and 1968).

Output data series for the forestry and fishery sub-sectors are timber, firewood, inland and marine fishes. The prices and production data for the forest and fishes were collected from the economic survey of Pakistan, 2013.

INPUT INDEX DATA

Input index of the present study comprised of the capital, labour and land. Present study input series for the capital consist of tractors, tube wells, working animals, fodder(Cotton seed data were used as fodder in the present study), fertilizers and pesticides. The prices and production data for the tractors, tube wells and animals were collected from the agricultural statistics of Pakistan (2013, 2007, 1980, 1976, 1975, and 1968). The import production data were collected for the fertilizers and pesticides from the economic survey of Pakistan, 2013.

Cultivated land and labour input were collected from various issues of Economic Surveys of Pakistan. Labour input has simply calculated by multiplying the number of agricultural labours by the average annual workdays i.e. 250 plus wage rates. The share of land has been measured by multiplying the cropped land with the annual rental value (Evenson, Pray et al., 1999., Ali and Iqbal, 2005 ). Data for the labours were collected from

All the above data were collected on the basis of the previous literatures includes Wizarat, 1981., Ali and Iqbal, 2004., Nadeem, Javed et al., 2010.

RESULTS AND DISCUSSION

This chapter presented the interpretation of the given results. The nature of the data is time series and data time span are from 1961-2013. This chapter comprises the results of the TFP index for analysing the technological progress across different decades in agriculture sector of Pakistan

TECHNOLOGICAL PROGRESS ACROSS DIFFERENT DECADES

According to the neo classical growth theory of solow(1957) that the incraese in total output was observed more by the technological change and a fraction by the total inputs. Current study analysis the growth of technological progress from 1961-2013. Total factor productivity index (TFP) is a proxy for the technological progress (Hayami, Ruttan et al., 1978., Crafts, 2003., Jajri, 2007., Akanbi, 2011). Table-4.1 calculated TFP index by using the Tornqvist-Theil (T-T) index approach.

Table-4.2 provides a detailed result about the input index. The element of table 4.2 has been calculated by simply taking data of capital, land and labour. Proxies for finding the percentage of each element are:

Capital % = ∑ capital cost/ total cost
Land % = ∑ land cost/total cost
Labour % = ∑ labour cost/ total cost
Table-4.3 provides a detail results about the total output index. Output index consist of four sub-sectors (crops, livestock, fish and forest) in agriculture sector of Pakistan. Each sub-sector index is individually calculated by Tornqvist-Theil approach.

Table 4.1 TP across different decades using Tornqvist-Theil (T-T) index

<table>
<thead>
<tr>
<th>Years</th>
<th>Output index</th>
<th>Input index</th>
<th>TFPindex</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-1970</td>
<td>4.084263255</td>
<td>0.982570548</td>
<td>3.10169271</td>
</tr>
<tr>
<td>1971-1980</td>
<td>4.023828506</td>
<td>1.063396975</td>
<td>2.96043153</td>
</tr>
<tr>
<td>1981-1990</td>
<td>4.041342038</td>
<td>1.044213736</td>
<td>2.9971283</td>
</tr>
<tr>
<td>1991-2000</td>
<td>4.005652172</td>
<td>1.090051151</td>
<td>2.94881086</td>
</tr>
<tr>
<td>2001-2010</td>
<td>4.012396304</td>
<td>0.990317476</td>
<td>3.03750624</td>
</tr>
<tr>
<td>2011-2013</td>
<td>4.036985917</td>
<td>1.775567012</td>
<td>2.2614189</td>
</tr>
</tbody>
</table>

Table 4.2 Utilization of capital, labour and land across different decades

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital %</th>
<th>Land %</th>
<th>Labour %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-1970</td>
<td>35.7423423</td>
<td>32.1288288</td>
<td>32.1288288</td>
</tr>
<tr>
<td>1971-1980</td>
<td>53.8499885</td>
<td>23.0228201</td>
<td>23.1271915</td>
</tr>
<tr>
<td>1981-1990</td>
<td>42.5448056</td>
<td>28.7264385</td>
<td>28.7287559</td>
</tr>
</tbody>
</table>
In the history of Pakistan, the second five year plan (1960-1965) has achieved its targets successfully. Table-4.1 showed that the output rate is 4.08 percent while TFP is 3.1. The results showed that during green revolution the TFP has contributed positively and input rate is 0.98 percent which is also less than 3.1 percent. During green revolution the important factors on which the government emphasized was the abandonment of the food grain regulation, 50 percent subsidy was provided on the fertilizers, the establishment of support prices of grains (wheat) and substantial imports of pumps, tube wells and other farm...
machinery (Pakistan, 1968). Table-4.2 showed that contribution of capital was 35 percent and it was efficiently utilized which is the evidence of the positive growth in TFP (technological progress). Our results from 1961-1970 are aligned with the previous studies Wizarat (1981) and Rosegrant, Evenson et al. (1993). The third five year plan was from 1965-1970. During the start of this plan, a war between Pakistan and India took place. This war affected our economy in a certain way that resources were transferred from development activities to defence system. The government allocated new seed cum fertilizer based technology in all districts of four provinces. This strategy achieved the targeted growth up to some extent.

The average growth from 1961-1970 was highly significant. Further crops contribution was high as compared to livestock, Forestry and fishery. Studies reveal that increase in crop was 1.08, while, livestock 01 percent, Forest 01 percent and fish 1.002 percent. All sub-sectors were comparatively high growth during this period.

1971-1980

The forth plan (1970-1975) of Pakistan has been formulated on the basis of the last fifteen year experience but the plan could not be implemented due to the war with India in 1971 and separation of east Pakistan. During 1971-78 no medium term plan was framed out but for the feasibility they developed only ad-hoc plan. Table-4.1 also showed the effect of adverse TFP growth during this period. The output rate is 4.02 which showed 6% decline in growth from 1970. Input rate is 1.01 percent, showing 8% increase from 1961-1970. High input rate showing an inconsistency in economic policies which resulted in the decline of technological progress. The inefficient use of inputs it declined TFP by 2%. The main economic factors which declined growth rate during this period are sharp increase in the international prices of the fertilizers, which raised the burden of fertilizer subsidy. Pakistan term of trade had declined, decline in the distribution of the high quality seed (Pakistan,
Despite these shortcomings and depressed forces, the agricultural sector was still able to maintain positive growth during seven years.

Table 4.2 shows that 53% of capital input were used during the 70's and 80's, which explains that capital has been used in large amounts but due to mismanagement and other unfavorable situations, it did not increase productivity. From 1971-1980, a total of 5 percent of land was developed for cultivation, a 25% increase was observed in labors during this period. Pesticides, fertilizers, tube wells, and tractors were also doubled.

In Table 4.3, crop sector decreased from 1.08% to 1.008%, forest decline from 0.1% to 0.99%, fish declines from 1.002% to 1.001%. The only observed increase among all sub-sectors was only in the livestock sector, it increased from the 0.1% to 1.01%.

During the 70's and 80's, the worst growth were observed in the history of Pakistan. The navigating factors were draught conditions during 1972 and 1974, poor weather, heavy rains and floods in 1974 and loss of East Pakistan during the 1971 war. The results of the 80's decade are in line with (Wizarat, 1981., Khan and Salam, 1997., Ali and Iqbal, 2005).

1981-1990

In this decade, the 5th (1978-1983) and 6th (1983-1988) plan has worked for the betterment of the agricultural sector. In 1978 and in 1980's, the 5th five year plan had successfully improved the worst condition of agriculture. Table 4.1 showed that output growth rate has been increased from 4.02 percent to 4.04 percent. It means that growth has improved 0.04%. TFP rate has increased from 2.96% to 2.99%, total change is 0.01% due to less use of total inputs. The 5th plan main features of the three year programs were the phasing out of the fertilizers subsidy over the last three years and replace it with the agricultural development programs (Pakistan, 1982). The 6th plan main objective was the maintenance of the momentum of the growth. And for the maintenance of growth, human resource
development factor has been targeted. Fertilizers subsidy has decreased more from 8 million to 3 million in 1990 (Pakistan, 1991).

Table-4.3 showed that capital percentage is decreased from 53% to 42% and it is a good sign that fewer inputs were used and more output was produced. The results showed positive and high values for the output index and TFP, also the input index is low which showed us that government implements such policies which improve the technological factor of productions.

The results of the current studies are align with Ali, Mushtaq et al., (2008) but his TFP rate is 2.24%, output rate is 4.23% and input rate is 1.94% while the current results are TFP (2.99), output(4.04) and inputs(1.04). the difference between the values of the two papers are due to the sectors, Ali worked only on two sub-sectors livestock and crops while the present study are based on the four sectors livestock, fish, forest and crop.

1991-2000

The observed growth rate of TFP during this decade is 2.94%, output rate is 4.005% and input rate is 0.999%. Results of present period are a little different from 90’s. The main reasons of the decrease in TFP from the previous period are flood in the1989 and 1993. In the 7th five year plan (1988 to 1993) there was a remarkable production of cotton. The production of cotton in 1992 is 12 million bales but it decreased to 9 million in 1993 due to floods and leaf curl virus. The overall production of the agricultural sector has been observed well during the 7th five year plan and 8th five year plan (1993-1998). The main objectives of the plan were to become self-sufficient in the basic food items, improve the productivity by using the inputs efficiently. According to this plan, for the first time a productivity enhancement program was launched (Pakistan, 1991).

The capital has increased 1% from the 90’s decade it mean that more capital has been used during this period but due to mismanagement and unwanted disasters, TFP has declined.
According to the economic survey of Pakistan, livestock sector increased 5.8% against its target. While table-4.3 also provide the evidence of increase in livestock from the last decade. This period’s results of TFP are not in line with Ali and Iqbal (2005). Ali and Iqbal (2005) had only observed two sub sectors livestock and crops. The large production in livestock sector during this period increased the weight of Ali’s TFP from the 1990’s. While current study worked on all sub sectors. Therefore, increased in livestock is balanced with the decrease in other sub-sectors by which TFP has decline from the previous period. So it is concluded that all sub sectors of agricultural should be focused for maintenance of optimum TFP rate.

2001-2010

In the history of Pakistan the high rate of TFP has been observed only in 2nd five year plan (1960-1965), but after this period 2001-2010 is the only decade in which again the TFP rate increased. During current period TFP has contributed 75% in the total output growth. The present output rate is 4.01%, TFP rate is 3.03% and input rate is 0.99%. The country suffered from the draught problem during 2001-2002 due to which major crops were affected. In 2001 the 9/11 attack desperately affected Pakistan’s economy, the militant attack on the afghan border and flood of many afghan refugees entering into KPK increased burden on the country’s present resources. After these unexpected events in 2004, the government of Pakistan made such policies which recover the last year loss. The major contributions in the growth of TFP are cotton, wheat and rice in 2004. 7.5% increase has been observed in cotton from the last year while increase in the production of wheat and rice were 8.3 and 2.9 percent.

The growth of agricultural in 2008 has been observed 4.7% against the target 3.5% per annum. Crop contributed more, which contributed 7.7% against of that in the last year i.e. 6.4%. Livestock grew 3.7% in 2008 against 4.2% in 2004. Minor crops contributed 12% in 2008 against 10.9% in last year. Forestry has experienced negative growth rate since 2004.
Fish sub-sector grew 2.3% in 2008 against 9.2% in last year. The main factors behind the optimum growth in both 2004 and in 2008 are favourable weather, irrigation and easy access to credit (Pakistan, 2004).

During this period more labours and land for the cultivation been used as table-4.2 showed that increase in both land and labours are 30% against 28% in 1990-2000. But 5% decrease has been observed in the capital current decade. A decrease in capital is a good sign for TFP. It showed that government utilized resources efficiently by implementing favourable strategies.

2011-2013

In 2010 the 10th five year (2010-2015) plan has been developed in which 3 years has passed. During these three years TFP rate has declined from 3.03% to 2.06% and input rate increased up to 1.77% against 0.99 in last decade. But if we observed the current output rate it is also increase from the 4.01 to 4.03 it mean that 2% increase in growth has been observed. In 2012 high growth has been observed 3.1% against the 2.4% in 2011. Crops and livestock has contributed in the total output growth, As the table-4.3 showed that 1.5% increase has been observed in the crop sub-sector while 0.1% increase has been observed in the forest sub-sector. The significant growth in crops has been observed in sugarcane, cotton and rice. Increase in cotton crop is 5.4 against -13.4 in 2011. It showed that in 2011 cotton was severely affected by the flood and cotton leaf curl virus, but in 2012 the production of the cotton has been improved due to prepared land for cultivation. It has increase from 2689 thousand hectors to 2835 thousand hectors and by introducing the BT cotton seeds. Similarly the increase in sugarcane has been recorded 5.9% against the 4.8% in 2011. The main factors behind the good performance of sugarcane in this years is the land, lucrative market prices from the 2011 year production and the availability of inputs encouraged the former to grow more sugarcane(Pakistan, 2013).
More inputs are used but inefficiently utilized; the main reason is the heavy rain in Sindh province and floods in 2011. The above table showed that 34% labours and land has been used against the 30% in last decade.

In last, the overall growth during this period is favourable but due to bad weather and water condition the TFP growth rate was affected inversely (Pakistan, 2013).

CONCLUSIONS

This paper has studied the technological progress in agricultural sector of Pakistan. Technological change was first used by the Solow (1957). He criticized the work of Harrod (1939) and Domar (1946) and explained in his paper that output growth is not only affected by the inputs (capital and labor) while there is residuals which are left after the subtraction of total output minus total inputs. These residuals are called as a technical change. It mean the increase in total output is not only because of inputs but there is the technical change in the total input factors which has also a good impact on the output growth rate. Technological progress has calculated by the total factor productivity (TFP) index. The Tornquist tail index was found a good tool for the calculation of TFP. The data for the current study has been collected from the 1961-2013. The study has three main objective, To find the technological progress on the bases of four agriculture sectors, to investigate trend analysis by comparing output and input variables by Tornqvist-tail index, results of the study will be analysed on the bases of five-year plan in Pakistan.

The current study established that average annual technological growth rate of Pakistan’s agriculture productivity was premier (3.1 percent) during 60’s and lowest (2.96 percent) during the decade of 70s and (2.94%) in 2000. The decade of 90s recorded average TFP rate of 2.99%, respectively and again reached to the 3% in the decade of 2010. The
results depicted that the role of input was insignificant except for the period of 70s and 2000 and it was technological progress that consequent growth in agriculture sector. The study observed the past background of Pakistan’s agriculture during the different eras in order to find out the possible details which were accountable for the variations in productivity growth rates of agriculture. For first time this study calculated TFP of all sub-sectors in agriculture sector of Pakistan. During 60’s all sub-sectors were above 1 percent and during 70’s when the rate of forest decline from 1 to 0.99 it affected the total growth rate. Therefore, the result of the individual TFP rates for each sub-sector showed that all sector contributed competently. On the investigation of estimated TFP results, government interpolations and developments in agriculture all sectors, the policy sanctions have been made to improve TFP rate. Based on the conclusions it is recommended that the government should try to improve their implementation strategies and provide the good mechanism to the farmers, in order to efficiently utilize the current resources. Further, the Government should focus on all the subsectors of agriculture equally, because government neglected the forest subsector after 1970 and if government would have developed a productive plan for the forestation the flood rates will also be reduced and ultimately crop lands will be safe from the large destructions
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