ESTIMATING GROWTH RATES AND DECOMPOSITION ANALYSIS OF AGRICULTURE PRODUCTION IN PAKISTAN: PRE AND POST SAP ANALYSIS

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ABSTRACT

This paper investigates the trends in area, production and yield of major crops (wheat, rice, sugarcane and cotton) of Pakistani agriculture by using component analysis model. The study data period has been divided into two periods: period one, 1972 to 1988, represents the pre structural adjustment period, and period two, 1989 to 2009, is the post structural adjustment period. The comparison of production and acreage growth rates in both periods revealed that wheat, sugarcane and cotton, but not rice, show better performance in period one. Yield growth rate comparison shows that wheat and cotton have better growth rates in period one while rice and sugarcane performed better in period two. The decomposition analysis of growth suggests that for wheat, rice and cotton, yield effect is the major source of growth in period one except for sugarcane for which area effect was the major source. In period two, source of output growth for wheat and cotton was the yield effect; for sugarcane and rice, the growth source was the area effect. The sources of output for the overall study period revealed that in case of individual crops, the main output source was the yield effect for wheat and cotton and the area effect for sugarcane and rice. The aggregate results for major crops show that in period one, the source of output growth is due to the yield effect; in period two, the output growth is due to the area effect. However, the analysis for the overall study period for aggregate crops revealed that the area and yield effects had almost equal contribution to total change in output growth.

Key Words: Agriculture, major agricultural crops, structural adjustment program, growth rate, decomposition analysis

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INTRODUCTION

Pakistan is relatively poor country with only US$ 1046 per capita income (Economic Survey, 2007-08). On average, economic growth continued at 6% per annum except for the last year since late 1960s. Although the share of agriculture sector has been steadily declining than of other sectors, where in manufacturing and services share is increasing but still agriculture remained a dominant sector of the economy. This is one of the characteristic of any developing economy where the agriculture sector contribution is shrinking by expanding the share of other sectors of the economy. Agriculture sector absorb nearly half of the labor force and account for around 70% of export revenue. The direct and indirect roles of agriculture are very important in inducing economic growth. A study of Asian countries where agriculture is the mainstay of the economy found that an increase of 1% per capita agricultural growth led to a 1.5% increase in per capita growth of nonagricultural (Mellor 1994). The author explained two main reasons for a larger increase in non agriculture growth as a result of agriculture growth. Firstly, agriculture has strong backward linkages to industries related to farm inputs, including chemicals, fertilizers, machinery as well as food and fiber processing. Secondly, increases in agricultural incomes are usually spent on locally produced goods and services especially exhibiting high income elasticities to demand and promote employment. Thus, increased agricultural productivity is positively correlated with overall economic growth that tends to increase rural employment and alleviate absolute poverty.

The need for agricultural growth is very vital in the development of an economy. Some researchers have found out that it is necessary to maintain a sustainable agriculture growth regardless of how fast the nonagricultural sector grows. Mostly economists agree that agricultural growth is not only an essential component but also a precondition for growth in the rest of economy. To keep pace of sustainable economic growth, quantitative assessment of the contribution of various factors to growth of agricultural output is important. There are many factors responsible for the agriculture growth. Among these, area and yield are the one (Singh 1981). These sources of growth are very important for agricultural development programs and for investment priorities (Ranede, 1980). Knowledge of difference in growth rates is important to remove the bottlenecks in achieving the speedy development in agriculture sector (Sikka and Vaidya, 1985).
Growth decomposition in agriculture output has remained very important issue for researchers and policy makers. To facilitate output project with alternative targets and policies, the breakdown of growth into various components such as area, yield and cropping pattern is important (Jamal and Zaman, 1992). The trend of agricultural production in the past and the estimation of its growth rates can provide a basis for future projections of agricultural output. Therefore, the present study makes an attempt to analyze the agriculture growth and the contribution of various components to overall output growth for Pakistan from 1972 to 2009.

**Structural Adjustment Program and Agricultural**

Structural adjustment can be defined as a varied policy action (whether home growth or externally driven) that attempts to alter the nature, structure, and functioning of economies. There are mainly two types of objectives associated with these policies, short term and long term. The short term objectives of these policies were to stabilize the economies through reduction of budget deficits and balance of payment deficits, while the long term objectives were to maintain rapid economic growth by ensuring free markets. The structural adjustment consists of two different components. The first component is the stabilization component or macro reforms components which are managed by IMF. The aim of stabilization component is to achieve external and internal balance in short or medium period. The second component, managed by World Bank, is the structural adjustment which consists of reforms to free market forces and promote long term economic growth.

Agricultural reforms through direct government intervention in the agriculture sector have been a key part of the structural adjustment program in Pakistan. Indeed, the structural adjustment has officially been a rather stop-start process. During the regime of General Zia ul Haq, the first structural adjustment loans were issued, but then they were soon discontinued due to unsatisfactory compliance with conditionalities. In 1988, the first main loan package was signed to cover the fast growing budget deficit and declining remittances from Middle East. The main focus under this program was reducing the deficit, cutting subsidies, and reforming the financial sector. The structural adjustment process itself affects agricultural performance, sometimes adversely in the initial phase. The initial impact is very important in the successful implementation of the adjustment program. The experience of other countries underwent similar adjustment programs have shown that sometimes agricultural economy was hurt in the initial phase of structural adjustment, but benefited later from improved incentive structure and institutional changes brought by reforms (Faruqee, 1999).

**Specific Structural Adjustment Policy Measure in the Agricultural Sector**

Structural adjustment policy measures in the agriculture sector include:

i. The removal of all government subsidies on food and other agricultural products.

ii. Promotion of production and export of nontraditional agricultural products.

iii. Imposition of restrictive measures on food and other locally produced agro based raw materials.

The overall objective for implementing structural adjustment in agricultural sector was to increase agricultural production and product exports because of its relative importance to the economy with the ultimate goal of improving the overall economy.

**Objectives of the Study**

To examine the trends in area, production and yield of major crops (wheat, rice, sugarcane and cotton) of Pakistan agriculture during the pre- and post-structural adjustment programs.

To examine the sources of output growth of major crops of Pakistan agriculture using the Decomposition analysis during the structural adjustment period.

**MATERIALS AND METHODS**

The present study is based on secondary data for the 38 years period form 1972 to 2009. The study examines growth rates of area, production and yield of wheat, rice, sugarcane and cotton. The study period has been divided in two parts to appraise the impact of structural adjustment program including pre reform period from 1972 to 1988 and post reform period from 1989 to 2009. Also, analysis was conducted for the entire study period of 38 years. The estimation of growth rate was mostly done by employing two common methods of growth rate including Linear Growth Rate and Compound Growth Rate (CGR). The linear growth rate has inherent limitations to perform the comparison of growth rates between periods and crops. Thus, it seems more appropriate to use the compound
growth rate for analyzing the growth trend of agricultural crops between two periods. The compound growth rate (CGR) is estimated by fitting a semi-log trend equation (1) of the following form:

\[
\ln Y = a + bt \tag{1}
\]

where, \( Y \) defines the time series data of production, area and yield of major crops i.e. wheat, rice, sugar cane and cotton, 't' is the trend term and 'a' is the constant coefficient. The slope coefficient 'b' measures the relative change in \( Y \) for a given absolute change in the value of explanatory variable 't'. If we multiply the relative change in \( Y \) by 100, we will get percentage change or growth rate in \( Y \) for an absolute change in variable 't'. The slope coefficient 'b' also measures the instantaneous rate of growth. We can calculate the compound growth rate using the following equation:

\[
\text{CGR} = \left(\text{antilog } b - 1\right) \times 100 \tag{2}
\]

The equation (2) has been estimated by applying Ordinary Least Square (OLS) method. The t-test was applied to test the significance of 'b'. This equation presumes that a change in agriculture output in a given year would depend upon the output in the proceeding year (Deosthali and Chandrehekhar, 2004).

To measure the relative contribution of area and yield towards the total output change with respect of individual crop, component analysis model has used. In the literature, several researchers have used this model to study growth performance of the crops (Bastine and Palanisami, 1994; Bhatnagar and Nandal, 1994; Mundinamani et al., 1995; Gupta and Saraswat, 1997; Singh and Ranjan, 1998; Siju and Kombairaju, 2001; Kakali and Basu, 2006).

\[
\Delta P = A\Delta Y + Y\Delta A + \Delta A \Delta Y \tag{3}
\]

Change in production = Yield effect + Area effect + Interaction effect

Thus, the total change in production is attributed due to area and yield that can be decomposed into three effects viz; yield, area and interaction effects.

This study is only restricted to the major crops (Wheat, Rice, Sugarcane, and Cotton) of Pakistan. The selection of the study period was mainly due to availability of data for this period of time. Selected crops account for more than 66% of total cropped area. The data has been collected from various secondary sources including Agriculture statistics of Pakistan (various issues), Economic Survey of Pakistan (various issues), and fifty years of Pakistan in statistics. The time series data on area, production and yield of these crops have been collected from these secondary sources. The entire study period has been classified into two periods to check the impact of structural adjustment program and to asses the changes in relative contribution of different factors towards the output growth overtime. The sub periods are period 1, from 1972 to 1988, termed as pre-structural adjustment program period and period 2, from 1989 to 2009, termed as post structural adjustment program period.

RESULTS AND DISCUSSION

**Pre Structural Adjustment Program (1972 to 1988)**

The Table I show the production, yield and acreage trend of major crops in the pre structural adjustment period, post structural adjustment period and overall study period. The production growth rate for major crops has increased by 3.35% per annum during the pre structural adjustment period. Among these major crops, the cotton has recorded the highest annual production growth rate of 4.66% followed by wheat having growth rate of 3.65% per year in pre adjustment period. Similarly the growth rates of sugar cane and rice were found 3.07 and 2.14% per annum, respectively. Growth in yield is the main source of growth in the productivity of agriculture crops. Overall yield performance of major crops has been increased by 0.63% per year during the pre structural adjustment period. The highest yield growth rate has been recorded for cotton with annual growth rate of 2.99% followed by wheat with growth rate of 2.24% per annum. The yield growth rate of sugar cane and rice were recorded to the tune of 0.55% and 0.36% per year, respectively during this period.

According to Table I it is clear that overall area of major crops has increased by 1.55% per annum during the period 1. Among these major crops, the sugarcane has recorded the highest acreage growth rate of 2.51% annually. This has been followed by rice with acreage annual growth rate of 1.77%. Similarly the acreage growth rate of cotton and wheat were found 1.61% and 1.38% per year, respectively.
The post structural adjustment period is also shown in Table I. Overall, production growth rate for major crops has increased by 1.83% per year during post structural adjustment period. Among these major crops, the largest increase has been recorded by rice at the production growth rate of 3.76% per year. Production of wheat and cotton has been increased at the annual growth rate of 2.34% and 1.65%, respectively. The production growth rate for sugarcane was found 1.45% per annum, which was relatively low as compared to targeted crops during the post structural adjustment period.

The important factor in order to increase the production of agricultural crops is the improvement in yield per hectare. Overall yield of major crops has been increased by 0.78% per annum during the post structural adjustment period. The highest yield growth rate has performed for rice to the tune of 1.94% growth rate followed by wheat with growth rate of 1.56% per annum. The annual yield growth rate of cotton and sugar cane has been recorded 1.30 and 0.60%, respectively. In Table I, the acreage growth performance during post structural adjustment program period shows that total area under major crops has increased at the annual rate of 0.86%. Of these major crops, the rice has experienced the highest acreage growth rate at 1.79% per year. It is followed by wheat and sugarcane with annual acreage growth rates of 0.76%. The acreage growth rate of cotton was lowest with 0.35% annually for the post structural adjustment period than all other targeted crops.

**Post Structural Adjustment Program Period (1989 to 2009)**

The compound growth rate of major crops during the post structural adjustment period is also shown in Table I. Overall, production growth rate for major crops has increased by 1.83% per year during post structural adjustment period. Among these major crops, the largest increase has been recorded by rice at the production growth rate of 3.76% per year. Production of wheat and cotton has been increased at the annual growth rate of 2.34% and 1.65%, respectively. The production growth rate for sugarcane was found 1.45% per annum, which was relatively low as compared to targeted crops during the post structural adjustment period.

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**Overall Study Period (1972 to 2009)**

During this period, the production of major crops increased at the growth rate of 1.29% per year. Among the major crops, the largest production increase was achieved by wheat at the annual growth rate of 3.27% per year, followed by rice with growth rate of 3.0% per year. The production of cotton and sugarcane crops increased at the rate of 2.91% and 2.48% per annum, respectively.

The results of Table I reveal that yield per hectare of major crops have increased at the annual rate of 0.88%. Of the major crops, the largest increase has been noticed in case of wheat with the annual rate of 2.06% followed by cotton with the annual rate of 1.92%. The productivity of rice and sugarcane has also increased at the annual growth rate of 1.09 and 0.81%, respectively. The compound growth rate of major cropped area during the entire study period increased at 1.29% per annum. Amongst the major crops, the largest increase in area was for rice at the annual growth rate of 1.89%, followed by sugarcane to the tune of 1.65% per annum. The acreage growth rates for wheat and cotton were found at 1.18 and 0.97%, respectively, for the entire study period.

**Comparison of production, Yield and Acreage Growth Rate in Pre and Post Structural Adjustment Period**

The comparison of both periods revealed that during the pre structural adjustment period production compound growth rate was estimated at 3.35%, compared to 1.83% per year during the post structural adjustment program period. The acreage compound growth rate turned out to be 1.55% during pre structural adjustment program period as compared to 0.86% during post adjustment period. The yield growth rate was estimated at 0.63% in pre structural adjustment period relative to 0.78% during the post structural adjustment period. It is clear from the comparative analysis that the performance of aggregate major crops during pre structural adjustment period is better in terms of production and acreage growth rate per annum than post structural adjustment period. But an aggregate yield growth rate performance was better in post structural adjustment period. If we see the individual performance of major crops, the results show that yield growth rate performance of wheat and cotton was better in pre structural adjustment period and rice and sugar cane growth performance was better in post adjustment period. The comparison of production growth rate for individual crops growth rates in both periods revealed that wheat, sugarcane and cotton performance were better in pre structural adjustment period and rice crop performed better during the post structural adjustment period. Similarly, the acreage growth rate comparison shows that wheat,
sugarcane and cotton growth rate per annum were better during the pre structural adjustment period, wherein the rice growth rate was better in terms of production and yield during the post structural adjustment period.

In sum, wheat had the best the overall growth rate performance among individual commodities, while rice crop performed better more in terms of acreage growth per annum during the entire period of the study. The best performance of wheat was followed by the productivity growth of cotton, rice and sugarcane in this order.

Decomposition and Output Growth of Individual Crops

The growth analysis (area, production and yield) of major crops revealed the general pattern of growth and direction of changes in yield and area. But this analysis does not evaluate the contribution of area and yield towards the production growth. So, it is necessary to examine the sources of output growth. To appraise the sources of output growth for major crops, the change in production is divided into three effects i.e., area effect, yield effect and interaction effect. The relative contribution of area, yield and their interaction to changes in production of individual crops is presented in Table II.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Effect</th>
<th>1972 to 1988 Pre Adjustment Period</th>
<th>1989 to 2009 Post Adjustment Period</th>
<th>1972 to 2009 Over All Study Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>Area</td>
<td>-51.41957645</td>
<td>6.690401049</td>
<td>-17.48706495</td>
</tr>
<tr>
<td></td>
<td>Yield</td>
<td>153.30636</td>
<td>92.11977481</td>
<td>117.5742324</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>-1.886783526</td>
<td>1.189824143</td>
<td>-0.087167454</td>
</tr>
<tr>
<td>Rice</td>
<td>Area</td>
<td>37.71477307</td>
<td>96.4758949</td>
<td>59.8299494</td>
</tr>
<tr>
<td></td>
<td>Yield</td>
<td>60.60916225</td>
<td>4.121625429</td>
<td>39.33148251</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>1.676064675</td>
<td>-0.597520333</td>
<td>0.838568096</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>Area</td>
<td>719.1041628</td>
<td>79.88731749</td>
<td>355.0949415</td>
</tr>
<tr>
<td></td>
<td>Yield</td>
<td>-641.6356035</td>
<td>21.01352078</td>
<td>-264.421938</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>22.53144064</td>
<td>-0.900838268</td>
<td>9.326996435</td>
</tr>
<tr>
<td>Cotton</td>
<td>Area</td>
<td>-15.45742842</td>
<td>-41.40086258</td>
<td>-30.95522976</td>
</tr>
<tr>
<td></td>
<td>Yield</td>
<td>111.5009936</td>
<td>138.1831412</td>
<td>127.4145165</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>3.956434809</td>
<td>3.21772143</td>
<td>3.540713236</td>
</tr>
</tbody>
</table>

Source: Authors’ Estimation

The decomposition analysis is employed for three periods as shown in Table II. The period one represents 1972-88, and termed as the pre structural adjustment period. The period two is from 1989 to 2009 and termed as the post structural adjustment period. During the pre structural adjustment period (1972 to 1988), an increase in output for wheat, rice and cotton was mainly due to increase in yield with the respective yield contribution towards productivity for these crops of 153, 60 and 111%. The area effect was the major driving force for sugarcane output growth in pre structural adjustment period. About 719% growth in sugarcane was due to area effect which more than offset the negative yield effect of 641% in sugarcane.

In post structural adjustment period (1989 to 2009), the main source of output growth of wheat (92%) and cotton (138%) was due to yield effect, while the increase in output growth of about 79.88% (in case of sugarcane) and 96.47% (in case of rice) was due to area effect. The decomposition analysis of the growth of major crops over the entire study period (1972 to 2009) revealed that growth in production of wheat and cotton was mainly due to yield effect ranging from 117 to 127%. However, the decomposition analyses show that production of sugarcane and rice was mainly due to area effect. About 59.82% (for rice) to 355.09% (for cotton) growths in crop were due to area effect.

Decomposition and Output Growth for Aggregate Crops

The relative contribution of area, yield and their interaction to change in production of aggregate major crops (wheat, rice, sugarcane and cotton) is presented in Table III. The decomposition analysis of the growth of major crops show that in pre structural adjustment period (1972 to 1988) the growth in production is mainly due to yield effect at about 75.02%. The post structural adjustment period (1989 to 2009) results show that the area growth of 71% was the major source of growth output. The overall study period (1972 to 2009) revealed that the area and yield effects have nearly equal contribution to total change in output growth.
Table III  Growth decomposition in production of aggregate major crops (Wheat, Rice, Sugarcane and Cotton) (%) periods

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Major Crops</td>
<td>Area</td>
<td>24.30713</td>
<td>70.98486</td>
<td>50.21429</td>
</tr>
<tr>
<td>(Wheat, Rice)</td>
<td>Yield</td>
<td>75.02696</td>
<td>30.30267</td>
<td>50.13312</td>
</tr>
<tr>
<td>Sugarcane, Cotton</td>
<td>Interaction</td>
<td>0.665917</td>
<td>-1.28753</td>
<td>-0.34742</td>
</tr>
</tbody>
</table>

Source: Authors’ Estimation

CONCLUSION AND POLICY IMPLICATIONS

There is a growing interest among the policy makers and academia in conducting impact assessment especially to assess the effectiveness of the policies after implementation of structural adjustment package. The knowledge of the impact of structural adjustment program will eventually help the policy makers to come out with better policies and corrective measures. In this paper, we have analyzed the impact of structural adjustment program through comparison of production, yield and acreage compound growth rates of major crops for Pakistan agriculture. It is clear from the results that growth rates in both periods were different for individual as well as aggregate crops. The results clearly show that the growth rate performance of major crops, except rice, was better in pre structural adjustment period than under the post-structural period in which subsidy for agriculture was reduced. The main focus of structural adjustment program prescribed by IMF was to reduce budget deficit by reducing subsidies and financial sector reforms.

The results of decomposition analysis for examining the sources of output growth show that sources of output growth were different in both periods. During the pre adjustment period, increase in output was predominant in case of wheat, rice and cotton, and this growth was mainly due to the yield effect. In case of sugarcane, the area effect was found to be a key source of output growth. In the post structural adjustment period, the source of output growth in wheat and cotton was due to yield effect. However, in case of sugarcane and rice, the major source of growth was accounted for by the area effect. For the overall study period of 1972 to 2009, results for output growth sources show that in case of wheat and cotton, the major growth factor was the yield effect, but for sugarcane and rice the main growth source was the area effect. The aggregate result for major crops (wheat, rice, sugarcane and cotton) show that during the pre-structural adjustment period 1972-88, the production growth is mainly due to yield effect. However, during the post structural adjustment period 1989-2009, the major source of output growth was the area effect. Interestingly, in the overall study period 1972-2009, the area and yield effects contributed equally towards the total change in output growth for aggregate crops.

The results of decomposition analysis have important policy implications because each growth component alone has a limited scope to expand overtime. For example, land’s growth potential (the acreage effect) is limited due to the scarce supply of water resources. If the current yield trends continue, the growth in crops production will decline overtime because of the limitations on land growth potential. In addition, some arable land would likely be reduced to accommodate the residential land needs of a growing population, which would likely have a negative effect on per capita production. There is an urgent need to increase crop production, particularly the food grains production, which will become inevitable in view of population growth. As such, efforts have to be directed toward further increasing the productivity of various crops. The future government policy should focus on developing new high-yielding varieties in Pakistan. Research efforts are needed to strengthen the crop breeding programs using new efficient technologies. Further, developing and establishing the bio-technology programs should be intensified to develop high yield varieties of the crops suitable to agro-climate conditions of the regions.

REFERENCES


