SJIF IMPACT FACTOR (2015): 5.42 CRDEEP Journals
International Journal of Basic and Applied Sciences Endrias Geta Vol. 6 No. 4 ISSN: 2277-1921
International Journal of Basic and Applied Sciences. Vol. 6 No. 4. 2017. Pp. 151-154

Full length Research ***Paper***

Estimation of Output Growth Rate and Contribution of Area Expansion and Productivity Improvement for Maize Production in Ethiopia

Endrias Geta
Senior Researcher and Coordinator, Socioeconomics Research Program, South Agricultural Research Institute, Hawassa, Ethiopia.

Article history
Received: 03-08-2017
Revised: 08-08-2017
Accepted: 14-08-2017

Corresponding Author:
Endrias Geta
Senior Researcher and Coordinator, Socioeconomics Research Program, South Agricultural Research Institute, Ethiopia

Abstract
Maize is major cereal crop with immense potential of output growth in Ethiopia. The government of Ethiopia embarked on the ongoing extension program to promote agricultural growth in 1995 in which maize has been the top priority crop. This study was set out to analyze the growth rate in production, area and productivity of maize crop in Ethiopia. Specifically, the study was initiated to estimate instantaneous and compound growth rates of maize output, area and productivity; and to examine the sources of growth in maize output over the period (1995/1996-2011/2012). The study utilized time series data on aggregate maize production, area and productivity for the period. A semi-log growth rate model and component analysis model were estimated to achieve the objectives of the study. The findings show that there was accelerated growth rate in maize production, area and productivity of about 6.2%, 3.5% and 2.6%, respectively, over the study period. It is also observed that the major source of growth in maize output is improvement in productivity which contributed about 72% of the total output growth rate. Thus, productivity enhancing efforts and intensive maize production system have to be encouraged instead of area expansion which is limited in scope.

Keywords: *Maize, Area, Production, Productivity, Growth rate*

Introduction

Ethiopia is predominantly an agricultural country and agriculture plays a major role in the country's economy. It accounts for about 42 percent of the GDP, 85 percent of the employment and 90 percent of the export (CSA, 2013a). Rapidly growing population, environmental degradation and low agricultural productivity are major problems faced by the country. It, one of the world's centers of genetic diversity in crop germplasm (McCann, 2001), produces more maize than any other crop (CSA, 2010). The area under maize cultivation in 2009/10 was 1.77 million hectares, from which 38.97 million quintals of maize were produced, and the amount was higher than any other cereal crop production. From the country's total grain production, maize accounts more than 21.56 percent.

The extension program initiated by the current government of Ethiopia known as the Participatory Demonstration and Training Extension System (PADETES) has been implemented since 1995 with the aim of increasing the productivity and production of smallholder farmers. The program has focused on maize because maize has the ability to respond positively to improved inputs, and thereby to achieve dramatic growth in productivity (Samuel, 2006). It is, therefore, important to study the growth rate of maize production, area and productivity after the implementation of this extension program so as to draw lessons and guide future policy directions. The objectives of this study were to estimate the instantaneous and compound growth rate of maize production, area and productivity; and examine the sources of growth in production in Ethiopia over the study period.

Materials and methods

Study area

This study is based on the secondary data that covers all maize producing areas of Ethiopia. The data were extracted from the official reports of the Central Statistical Agency (CSA) of Ethiopia for the period from 1995/1996 to 2011/2012 on production (total output), area coverage and productivity (yield per unit area) of maize crop. Ethiopia, the study area, is located in East Africa having an estimated population of over 90 million (CSA, 2013b) which stands second in Africa after Nigeria. It occupies a total area of 1,100,000 square kilometers. Agriculture is the basis of livelihood of over 85% of the population. The country has diverse agro-ecologies suitable for production of several kinds of crops. Maize is one of the major crops produced and considered to be the top priority crop for achieving food security by the government.

Methods of data analysis

The data were analyzed using a semi-log growth model following Gujarati (2004). A well-known compound interest formula was applied to the problem of maize production, area and productivity. Productivity in this case is defined as the ability of a unit of an input to produce a certain level of output (Harsh *et al*., 1981). In crop production, yield per area (amount of crop harvested per amount of land planted) is the most commonly used indicator of productivity (Diskin, 1999) and followed in this study.

The steps followed to estimate growth rates and decompose production growth rate are presented as follow.

The compound growth rate formula is

$$Y_t = Y_0(1 + r)^t \quad (1)$$

Where

Y_t= *area/production/productivity of maize in year t*

Y_0 = *quantity of maize produced/ area/ yield in the base year*

r = *compound rate of growth of Y*

t = *time in chronological years*

By taking natural logarithm of both sides of the equation,

$$\ln Y_t = \ln Y_0 + t\ln(1 + r) \quad (2)$$

By substituting $\ln Y_0$ with β_1 and $\ln(1+r)$ with β_2 and adding the disturbance term U_t, equation (2) is rewritten as

$$\ln Y_t = \beta_1 + \beta_2 t + U_t \quad (3)$$

This is a semi-log growth rate model estimated in this study. A semi-log growth rate model is developed for this study instead of a linear trend model because the study is interested in both absolute and relative change. In equation (3), β_2 is the slope coefficient which measures the constant proportional or relative change in Y for a given absolute change in t. The instantaneous growth rate (IGR) is obtained by multiplying β_2 by 100, i.e.,

$$\beta_2 \times 100 = \text{IGR} \quad (4)$$

The compound growth rate (CGR) is computed by taking the antilog of β_2 and subtracting 1 from it and multiplying the difference by 100 as follows.

$$\text{CGR} = [\text{antilog}\ \beta 2 - 1] \times 100 \quad (5)$$

If β_2 is positive and statistically significant, there is acceleration in growth, if β_2 is negative and statistically significant, there is deceleration in growth, and if β_2 is not statistically significant, there is stagnation in the growth process.

To measure the relative contribution of area and productivity towards the total output change, a component analysis model was used. This model was applied by several researchers to study growth performance of crops (Siju and Kombairaju, 2001; Kakali and Basu, 2006; Rehman*et al.,* 2011*)*.

$$\Delta P = A_0\Delta Y + Y_0\Delta A + \Delta A\Delta Y \quad (6)$$

Where

ΔP = *Change in production*

$A_0\Delta Y$ = *Productivity effect*

$Y_0\Delta A$ = *Area effect*

$\Delta A\Delta Y$ = *Interaction effect*

Thus, the total change in production is attributed to area and productivity that can be decomposed into three effects, i.e., productivity, area and interaction effects.

Results and Discussion

From the result, it can be observed that the R^2 values of production, area and productivity models are 0.76, 0.80 and 0.66, respectively (Table 1). These indicate that much of the variation in maize production, area and productivity over the study period was explained by variation in time. The F-statistics for each model are statistically highly significant (p = 0.000) and indicate the adequacy of the models to explain the data. The coefficients estimated separately for maize production, area and productivity are positive and statistically highly significant (p = 0.000) indicating that there was a significant growth rate acceleration in maize production, area and productivity over the study period (Figures 1, 2, and 3). The coefficients of trend variable in Table 1 (0.060, 0.034 and 0.026) indicate that over the period 1995/1996–2011/2012, maize production, area and productivity in Ethiopia had annual instantaneous growth rate of 6.0%, 3.4% and 2.6%, respectively. The compound growth rate of production, area and productivity over the study period was 6.2%, 3.5% and 2.6%, respectively.

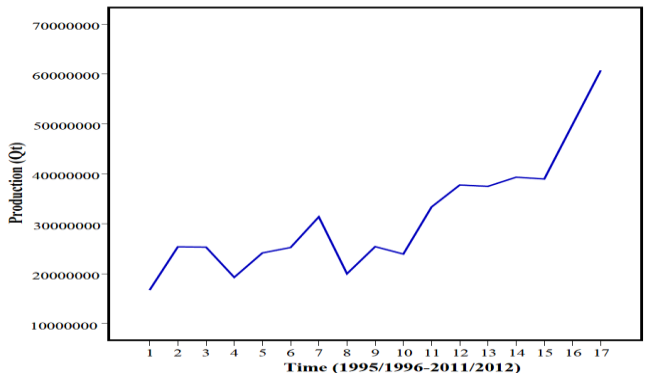

Fig 1. Growth of maize production in Ethiopia over 1995/1996-2011/2012

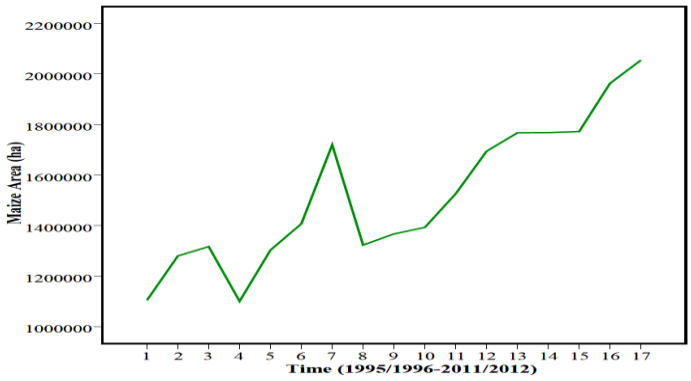

Fig 2. Growth of maize area in Ethiopia over 1995/1996-2011/2012

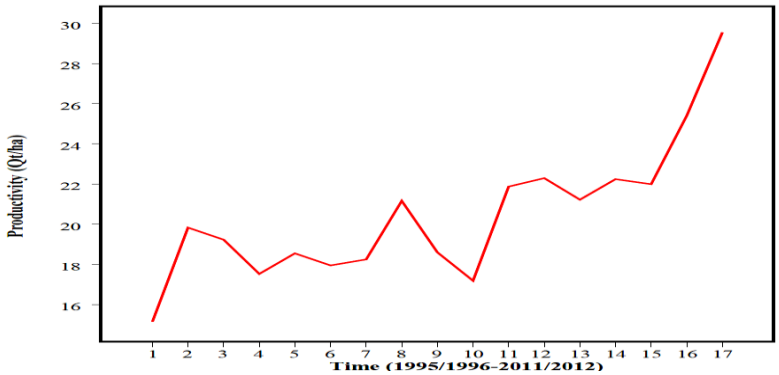

Fig 3. Growth in maize productivity in Ethiopia over 1995/1996-2011/2012

Regarding the source of growth in maize production, about 72 percent of the observed change in production is due to increased productivity (Table 2). This indicates that major source of the increase in production over the study period is an improvement in productivity. On the other hand, the maximum level of productivity attained (29.54 qt/ha) is far below the potential productivity of maize which indicates the existence of further scope to increase productivity and production.

Table 1. Production, area and productivity growth rate of maize over 1995/1996-2011/2012

Model	R^2	F	β_2	Instantaneous growth rate (%)	Compound growth rate (%)
Production	0.762	48.107***	0.060***	6.00	6.18
Area	0.804	61.492***	0.034***	3.40	3.46
Productivity	0.658	28.820***	0.026***	2.60	2.63

Table 2. Decomposition of maize output growth rate

Effect	Contribution (%)
Area	15.0377
Productivity	72.0302
Interaction	12.9322
Total effect	100.000

Conclusion and Recommendation

This study has examined the growth rates in maize production, area and productivity in Ethiopia from 1995/1996 to 2011/2012. The objectives of the study were to estimate the instantaneous and compound growth rates of maize production, area and productivity over the study period; and to examine the sources of growth in maize production. A semi-log growth and component analysis models were applied to estimate the growth rates and identify the sources of growth in maize production, respectively.

The result indicated that there was accelerated growth rate in maize production, area and productivity over the study period. Major source of growth in production was found to be improvement in productivity probably due the aggressive maize extension program launched by the government of Ethiopia in 1995. It can be recommended that increased effort has to be made by concerned authorities

to increase maize productivity as it is the major source of output growth in Ethiopia. Since area expansion has contributed less (15%) to output growth, it is recommended to promote intensive rather than extensive maize production system in the country.

References

CSA (Central Statistical Agency), 2013a. Agricultural sample survey (2012/13) report on area and production of crops, volume I. Addis Ababa, Ethiopia.

CSA (Central Statistical Agency), 2013b. Population projection for Ethiopia (2007-2037), Addis Ababa, Ethiopia.

Diskin, P., 1999.Agricultural productivity indicators measurement guide.Bureau of Global Program, USAID.

Gujarati, D.N., 2004. Basic econometrics, 4th ed. MacGraw Hill, New York.

Harsh, S.B. I.J. Connor and G.D. Schwab, 1981.Managing the farm business. Prentice-Hall, Inc.

Kakali, M. and P. Basu, 2006. Measurement of growth trend: an econometric study of food grains production in west Bangladesh. *J.Agric. Econ.,* 3(3):44-55.

McCann, J., 2001. Maize and grace: history, corn and Africa's new landscapes, 1500-1999. Society of Comparative Study and History.

Rehman, F.U., I. Saeed and A. Salam, 2011.Estimating growth rates and decomposition analysis of agricultural production in Pakistan: pre and post SAP analysis.*Sarhad J. Agric.,* 27(1):125-131.

Samuel Gebreselassie, 2006. Intensification of smallholder agriculture in Ethiopia: options and scenarios. Paper prepared for the Future Agricultures Consortium meeting at the Institute of Development Studies, 20-22 March 2006, Addis Ababa, Ethiopia.

Siju, T. and S. Kombairaju, 2001. Rice production in Tamil Nadu: a trend and decomposition analysis. *Agri. Situation in India,* 58(4):143-145.