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TREND ANALYSIS OF MAIZE PRODUCTION IN LESOTHO AND ITS DISTRIBUTION AMONG THE ECOLOGICAL ZONES

Morojele M.E. and Sekoli M.S

National University of Lesotho, P. O. Roma.180

ABSTRACT: *Maize is the major staple crop in Lesotho as evidenced by production and consumption levels. Speculation showed that maize production and area planted is declining dramatically and no appropriate analytical tools have been employed to verify this. The objectives of this study were; (1) to determine the trend of maize production, area planted and yield using time-series data (2) to determine distribution of maize by production and area among ecological zones. Time series data from 1961 to 2013 on maize production, area and yield were collected from FAOSTAT (2015). Data on ecological zones were obtained from Bureau of Statistics in Lesotho (2014). Genstat software was employed for trend analysis using time series function and ANOVA was to establish differences in maize production among ecological zones of Lesotho. The results revealed that trendline for maize production had declined from 107,000 in 1961 to 94,000 tons in 2013. Production and area curves appeared cyclical. Trendline for area planted maize for 54 years was constant from 1961 to 2013. Yield trendline was constant at 860 kg ha^{-1}. Maize production in the lowland was the highest, followed by Foothills, Mountain and Orange river zone. There is a potential for Lesotho to increase maize production by mainly increasing yield.*

KEYWORDS: Maize Production, Trend Analysis, Ecological Zone, Lesotho

INTRODUCTION

Maize is a major staple cereal crop in Lesotho ranking first followed by sorghum and wheat as evidenced by production level and area under which it is grown (Bureau of Statistics, 2013/2014). It is produced by all farming house-holds for mainly home consumption and low amount for sale in four ecological zones, namely; mountain areas, foothills, lowlands and Senqu river valley which have varying altitude, climate and edaphic conditions (Wilkem,1978; Moeletsi, 2004). The most dominant maize producers are smallholder farmers and some few commercial farmers who sell maize grains to the two Milling companies and Breweries existing in the country. Part of the produce from the commercial farmers is sold to the vendors in the street as green mealies, who in turn sell it as cooked or roasted. It is grown under rain-fed conditions where it is entirely depended on rainfall and moisture conservation techniques. More often, it is negatively affected by drought at very critical stages of growth, thus reducing yield negatively. The average yield of maize had been low due to area where it was grown, frequent spells of drought, frost, heat and hailstorms (Bureau of Statistics, 2013/2014).

Maize is an important source of carbohydrates, proteins, vitamins and minerals comparing favourably with other starchy crops such as rice and potatoes (Olaniyan, 2015). It is prepared into various products such as maize-meal pap, porridge, mixed with wheat meal to make bread and pop corns. In addition, it is fed to livestock as whole grain in the farms or can be processed into variety

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of products by feed mills. Maize stovers are fed to animals in winter season when animal feed is very scarce and expensive to maintain a large number of animals in good body condition.

The production of maize in Lesotho has been a great concern to the producers, milling plants, government and nation as a whole (Makoa, 2006). Production is inadequate to meet the country's requirement necessitating importation of supplementary maize grain from other countries like South Africa. This was not the case in the past five to six decades, Lesotho was exporting large amount of maize to South Africa for both home consumption and its maize industry, obtaining foreign exchange earnings (Hunter, 1978). The trend of maize production is not well documented using appropriate analytical tools, hence this study is undertaken. Besides, there is a speculation that declining production is due to erratic rainfall, low and high temperatures (frost and heat) and diminishing area under which is grown. These factors are have to be examined critically and their magnitude be estimated. The objectives of this study are therefore two folds; (1) to determine the trend of maize production using time-series data, (2) to determine distribution of maize by production and area among ecological zones.

MATERIALS AND METHODS

Study area

The study area was conducted in Lesotho which covers a surface area of 33,300 km^2. It lies in the temperate region of Southern Africa located between longitude 27^0 E and 30^0 E, latitude 28^0S and 31^0S, and altitude of 1400 and 3480 m above sea-level. The average annual rainfall is 750mm starting to rain in October and reaching the peak in January after which it declines sharply until April. Winter season experiences frequent spells of drought. Temperature ranges between 28^0C in summer to -5^0C in winter with snowfall in the mountain and foothill areas. Lowland may occasionally have snowfall.

Data collection and analysis

The study covered a period of 54 years from 1961 to 2013. Time series data on total production of maize, area planted and yield of maize were captured from Food and Agriculture (FAOSTAT, 20015) statistical database using Microsoft Excel (2000), after which it was transformed using natural logarithm.

In order to determine trend of maize production, area planted and yield, trend analysis was performed to reveal changes occurring over 54 year time-period using GENSTAT recovery developed by Buysse *et al*., (2004). This software programme also enabled the regression equation and coefficient of determination to be formulated and linear series to be drawn.

Time series data pertaining to ecological zones were obtained from Bureau of Statistics (2014). The ecological zones were Lowlands, Foothills, Mountains and Orange River Valley. Analysis of variance was performed using GENSTAT to determine the differences in maize production among the four ecological zones of Lesotho.

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RESULTS

The study examined the aggregate trends in maize production, area under maize and yield on hactare basis. It only assessed the country-wide production of maize disregarding performance at different ecological zones.

Maize production trends

Trendline in maize production showed a decrease of 12% from 107 000 tons in 1961 to 94 000 tons in 2013 with peaks and trough varying in depths and heights within 54 year time period. Nine peaks and eight troughs were observed. The highest production of 188 489 tons was achieved in 1996, followed by 171 579 tons in 1990 and 160 000 tons in 1988.

The bottom most troughs was achieved in 2012 where production of maize was 16,788 tons, followed by two troughs of 49,125 and 48,9818 tons in 1976 and 1991, respectively. These were further followed by three troughs of 57,126 tons in 2009, 62,531 tons in 1995 and 59,000 tons in 1972. Other small peaks and troughs lied around the trendline. From 1961 to 1967, production level was consistent maintaining the level of 110,000 tons. Figure 1 below depicted the production curve and trend line during the period under study.

Maize area trends

The area planted maize remained unchanged from 1961 to 1964 at 135,000 hactares. Similarly, there were nine peaks and nine troughs of varying levels noticed in the area planted during this time-period of 1961 to 2013. In 2001, the largest area of 177,485 hactares was planted, followed 173,214 hactares in 1988, then 172,743 hactares in 1994 and 168,765 hactares. The smallest area planted in this 54 year time-period was 76,955 hactares in 1995, followed by 80,336 hactares in 1977, then 90,461 hactres, 90, 030 hactres and 97,711 hactres in 1981,1998 and 2012, respectively. Other minor fluctuations were observed around the trendline. Trendline revealed constant area of 129,247 hactares planted maize over the time period of 54 years from 1961 to 2013. There was neither an increase nor decrease in the trend line. Graphic and trendline of area planted are presented below in Figure 1.

Yield trend in maize

Trendline revealed an infinitesimally small increase in the yield of 814,8 kg ha^{-1} in 1961 to 860.0 kg ha^{-1} in 2013 (Fig.1). During this time-period, there were four peaks lying above the trendline. Below the trendline, five troughs were experienced. Highest yield obtained was 1567.6 kg ha^{-1} in 1977, followed by 1317,1 kg ha^{-1} in 1998, 1249.0 kg ha^{-1} in 1996 and 1100 kg ha-1 in 1990. Below the trendline, three troughs of same yield of approximately 500 kg ha^{-1} in 1970 to1972, 1976 and 1991 to 1992 were observed. Lowest yield of 171.8 kg ha^{-1} and 15.94 kg ha^{-1} were realised.

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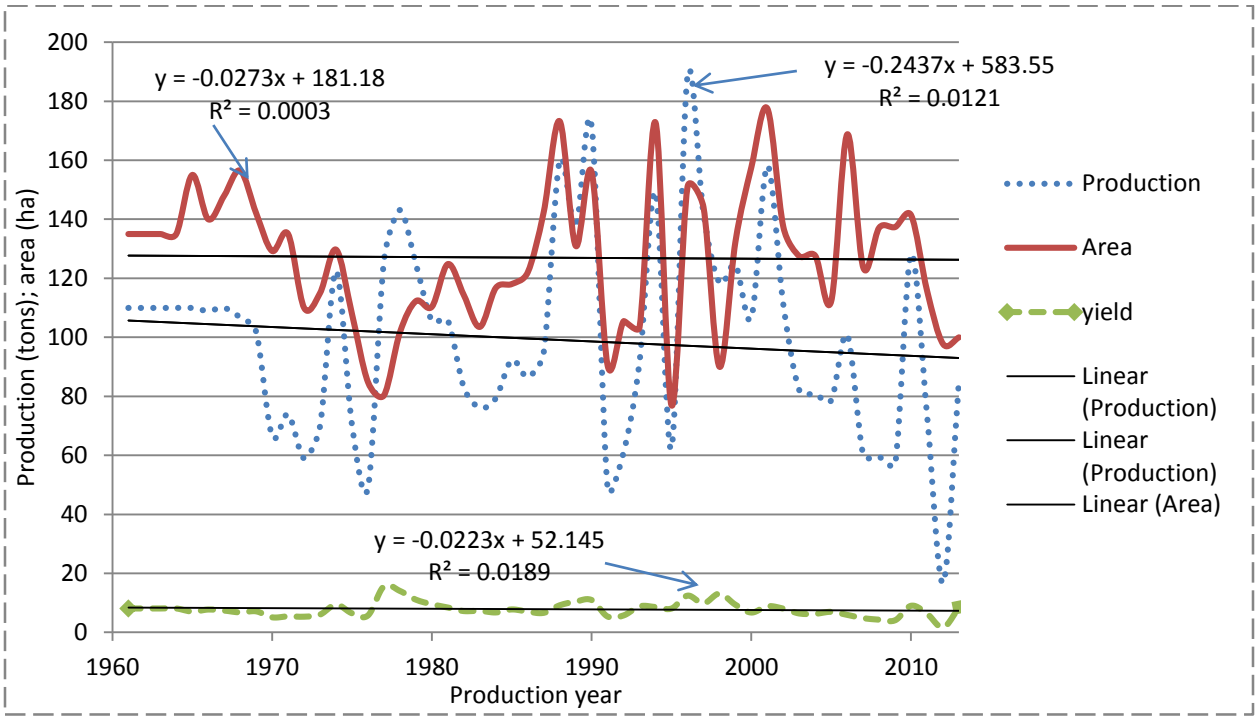

Fig.1. Production, area and yield trend curves and trendlines

Distribution of maize in ecological zones

A highly significant (P>0.01) difference in maize production among the four ecological zones was obtained (Table 1). The highest production of maize was grown in the Lowland zone which amounted to 158 081 tons and the lowest production attained for the region was 23 800 tons during the period under study. Foothill zone followed by a high and low production of 65 785 tons and 11 235 tons, respectively. The differences between the two zones were large. Maize production from Mountain zone was at par with Foothills and no significant difference was realized. Mountain zone produced 48 717 tons being the highest while the lowest production was 5 700 tons. This zone was signicantly lower than the other three zones. The Orange river valley showed the highest maize production of 14 751 ton and lowest production of 2 000 tons. The grand mean for four ecological zone for the period under study are presented in Table 2.

Table 1: Analysis of variance for maize production, area and yield in the ecological zones

		Production	Area
Source of variation	df	Mean Square	Means Square
Ecological zones	3	3.06556**	4.67729**
Residual	96	0.04041	0.06875
Total	99		
LSD (5%)		0.1472	0.1129
CV(%)		6.1	4.6

****** Highly significant

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Table 2 Means, highest and lowest values of maize production

Ecological zones	Production (tons)			Area (ha)		
	Means	Highest	Lowest	Means	Biggest	Smallest
Lowlands	60 814	158 081	23 800	64 936	118 586	28 976
Foothills	26744	65 785	11 235	25 423	47 836	11 237
Mountains	21236	48 717	5 700	25 810	37 008	14 000
Orange River valley	6659	14 751	2 000	9 611	15 600	2 757

DISCUSSION

Maize production trends

The production of maize in Lesotho declined slightly by 12% over a period of 54 years from 1961 to 2013 as indicated by the trendline. This drop was insignifcant. Nonetheless, there were peaks and troughs during this period which have been attributed to mostly climatic factors such as drought, heavy rainfall, late rainfall, hailstom, snow, wind and outbreak of pests (Bureau of Statistics, 2014). All these were natural calamities which were not under the control of the maize farmers. The nature of the heights and depths of peaks and troughs showed vividly that there was no control and there were some factors which had a perceptible influence over the maize production. Therefore, it would be of paramount importance to identify the factors and apply mitigation strategies. The number of peaks and troughs on the production curve were equivalent implying that low production of maize in a particular time-period was compensated by a high production in the following time-period. This pattern of alternating low and high production led to a cyclical production. When this production behaviour of maize was smoothed out a straight line with a slight decline was obtained. The results of this study were consistent with findings of Mairiga (2014) who conducted trend analysis of maize and sorghum in Nigeria from 1983 to 2008, and found troughs and peaks in both crops during this time-period. Similarly, Munyua *et al*.(2010) revealed a fluctuation in the production of maize in Kenya from 2002 to 2007. Fluctuation of high peaks and very low troughs in maize production and other crops are well documented where trend analysis exhibited results similar to this study (Manana, 2014; Bivan *et al*., 2013; Badmus and Ariyo, 2011).

Maize area trends

The area utilized for growing maize remained constant over the past 54 years from 1961 to 2013 as evidenced by trendline. The production and area curves seemed to follow a pattern similar to that of maize production. Similarly, there were times when very large areas were put under maize and followed by another time when area planted was small. The reasons for the fluctuations were late rainfall, drought prevalent in the beginning of the growing seasons, a change in the choice of a crop depending on the producer price, personal preference in that particular year, availability of farm power to start ploughing timeously and other production inputs (Bureau of Statistics, 2014). The area used for maize was also used for under crops creating a stiff competition among the crops produced by the farmer. Nonetheless, maize production and area planted maize seemed to be

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highly related such that where area was increased, production also increased. The results on areas put to maize were not unique for Lesotho, many researchers experienced similar findings when conducting trend analysis on areas planted maize. Angelucci (2012) analysed the trend in areas grown maize and found a fluctuation in the area used over time but trendine showed a steady increase in the use of land for maize production. The findings of other reseachers concured the results from this studies (Abbasi, 2015; Mazwell,2013; Van Huylenbroek and Mbithi, 2000)

Yield trend in maize

The yield of maize also remained constant throughout 54 year time period with infinitesimal small peaks and troughts. This could be attributed to less effort made by the farmer to improve maize productivity by applying modern technologies that will enhance productivity. Several efforts were made by the Lesotho Government by initiating projects, subsidies, funding and technical assistance but all were short-lived terminating even before improvements were realized (Bureau of Statistics, 2014). This was a futile effort to the Government. Changes in maize production were brought about by the changes in the area planted not productivity. In Zimbabwe, similar results were achieved where maize yield remained constant from 1970 to 1985 after which it increased slightly. Conversely, maize yields increased from 9707 kg ha^{-1} to 19571 kg ha^{-1} because of modern technologies applied by farmers, initiated by the Nigerian Government (Mairaga, 2014; Badmus and Ariyo, 2011).

Distribution of maize in ecological zones

Among the four ecological zones of Lesotho, lowlands accounted for the highest maize production reaching 158 000 tons on 118 586 hactares. The lowest production was in the Orange River Valley where 14 751 tons were achieved on 2 757 hactares. Foothils and mountain zones were at par. In the lowlands, arable area was bigger than the other zones and the climatic conditions allowed maize to be planted over a longer period, from October to Mid-November whereas in the foothills and mountain zones, planting can only commence in September and terminate in November due to early chilling injuries that the crop suffered. The Orange River valley is prone to drought and is very hot in summer resulting maize crop being adversely affected in growth and yield. Therefore this discouraged farmers to produce maize on a large scale. In most countries, production of maize and area under which it is grown differ greatly according to the regions. In Zimbabwe, areas such as Mashonaland, Manicaland, Midland, Masvingo and Matebeleland produced different quantities of maize using varying areas amongst the districts (Rohrbach, 1989). Again in Uganda, maize was produced in varying amounts in the districts of Kasese, Masindi, Kapchawa, Mbarara, Gulu and Lira where a total area of 684 000 hactares were planted (Balina,1992).

CONCLUSION

Lesotho has a potential to meet its requirement of maize provided crop productivity is increased through technology transfer and use of production inputs juduciously taking into consideration sustainability and enviromnemtal protection. There is no need to increase the area under which maize is produced. Maximum benefits can be derived if the key factors influencing yield are controlled and mitigating strategies employed.

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