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TREND IN BEAN (*PHASEOLUS VULGARIS* L.) PRODUCTION GROWN IN LESOTHO

Motlatsi E. Morojele and Lelima Mahlapane
National University of Lesotho, Faculty of Agriculture, Department of Crop Science,
P. O. Roma.180. Lesotho

ABSTRACT: *Common bean is a queen of legumes and a major source of protein and iron for many people in Lesotho. It is speculated that bean production, area planted and yield of common beans have been erratic throughout the period of 58 years from 1961-2017. This has not been verified statistically and documented, hence this study has been conducted to dispel or dispute the speculation. The object of the study was therefore to (a) estimate the trend in the production, area and yield of common bean over a period of six decades, (b) identify the key factors influencing bean production. Data on trend of common beans were obtained from Bureau of Statistics (2017), while data for factors affecting production were obtained from Lesotho Meteorological Service (2017). Excel spread sheet was employed to determine the trend of bean over the period of 58 years and ANOVA was to establish the significance of the factors contributing towards bean production. The results showed an average increase of 44% in the production, 42% increase in area planted and 2% decrease in yield. There were droughts and peaks during this time-period differing greatly. The factors of production did not significantly influence the bean production.*
KEYWORDS: Common bean, production trend, yield, area, Lesotho .

INTRODUCTION

Common beans (*Phaseolus vulgaris* L.) originated from Central America in the Andeans and Meso-American, and were probably domesticated there (Gepts and Paredes, 1995). They were carried to North America where they were grown by Native Americans for many centuries (Jones, 1999). From North America, they were carried to Europe by early explorers of the New World, and had undergone about 500 years of additional domestication and selection in Europe. The species has great agricultural varieties (Gentry, 1969). They are herbaceous annual plants grown worldwide for their edible dry seeds or unripe fruits (Jones, 1999). Common bean is highly nutritious providing proteins (15%), carbohydrates (15%) and valuable macro and micro nutrients such as calcium, potassium, phosphate, copper, zinc and manganese (Jerry, 2013) for more than three million people in the tropics (Camara *et al*. 2013). According to Akibodes and Maredia (2011), common bean is a staple food and major source of protein and iron for populations in Eastern Africa and Latin America. In many areas, common beans are complementary to maize as a relish with amino-acids which maize does not have (Onuewe, 2004).

Common beans are warm season legumes that grow well under sub-tropical and temperate conditions (Wortmann, *et al*. 2004). They are found in tropical areas but do not grow well under very wet conditions which cause fungal attacks and flower drop (Jones, 1999). They grow at optimum temperature of 18 to 24^0 C after emergence, day temperatures below 20^0 C retard bean growths. After flowering, low temperatures will lead to the formation of pods without

seeds while low night temperatures during pod filling will extend the growing season. Higher temperatures during flowering stage lead to abscission of flowers and poor pod set, resulting in a reduced yield (Graham and Ranolli, 1997). For dry land conditions, a total annual rainfall of 650-750 mm is regarded as ideal with a minimum of 400-450mm in the growing season (Camara *et al.* 2013). Low relative humidity leads to flower abscission and low pod set which is aggravated by low soil moisture (Jones, 1999).

Common bean is also an important leguminous crop in Lesotho regarded as a queen of legumes grown by most farming house-hold consumed as dry beans and immature pods. Their level of production and national requirement is a great concern to both policy-makers and farmers alike. Records revealed that demand for common beans in Lesotho is higher than the production necessitating importation from South Africa (Akibode, 2011). Due to deficit of bean production in Lesotho, it is vital to determine trend in production of beans as to whether it is increasing or decreasing. Production is the process of combining various agricultural inputs including soft skill in order to boost outputs (Jerry, 1999). Whereas trend is a general direction in which production is changing. It is a pattern of gradual change in a condition, output or process, or an average or general tendency of series of data points to move with time. To follow a trend, one must not only be aware of what was happening in the past and currently but be astute enough to predict what is going to happen in the future (Williams, 1996).

The government is making an effort to increase production by introducing new highly productive cultivars of common beans and improving agronomic practices. Both of these are expected to increase productivity but this may not be always necessarily the case. It is therefore imperative to measure the impact of the government as to whether they are yielding expected results. The object of the study was therefore to (a) estimate the trend in the production, area and yield of common bean over a period of six decades, (b) identify the key factors influencing bean production.

MATERIALS AND METHODS

Study area

The study was conducted in Lesotho. It lies in the temperate region of Southern Africa located between longitude 27^0 E and 30^0 E, latitude 28^oS and 31^0S, and altitude of 140^0 and 3480 m above sea-level. The average annual rainfall is 750 mm 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

The study covered a period of 58 years from 1961 to 2017 based on secondary data. Time series data on total production of beans, area planted and yield of beans were captured from Agricultural Production Survey Crops (Statistical Report, 2017) and entered in the Microsoft Excel (2000). Meteorological data were obtained from Lesotho Meteorological Services.

Data analysis
Data collected were entered in the computer using Excel spread sheet, after which it was used to draw linear graph. These data were further subjected to multiple linear regressions to analyse the influence of the factor affecting bean production.

RESULTS

The study examined the aggregate trends in bean production, area under beans and yield on hectare basis.

Beans production trends
The production of beans in Lesotho increased by 44% over a period of 58 years from 1961 to 2017 as indicated by the trend line. The production of beans showed an increase from 1,400 metric tonnes in 1961 to 4,000 metric tonnes in 1971 with peaks and troughs varying in depths and height within 58 year time period. Fourteen peaks and fourteen troughs were observed. The highest production of 20,865 tons was achieved in 1977, followed by 14,238 tons in 1997 and 10,783 metric tonnes in 1978. The lowest production of 1,400 metric tonnes was observed in 1961 and 1962, followed by 1,600 metric tonnes in 1963 and 1964 and 2,000 metric tonnes. Figure 1 below depicted the production curve and trend line during the period under study.

Beans area trends
The area covered for bean plantation has also increased by 42% as indicated by trend line. The area planted beans remained unchanged from 1961 to 1963 at 5,000 hectares. There were fifteen peaks and sixteen troughs of varying levels noticed in the area planted during this time period of 1961 to 2017. In 1976, the largest area of 29,656 hectares was planted, followed 28,063 hectares in 1975, then 27,743 hectares in 2006. The smallest area in this 58 year time period was 4,600 hectares in 1993, followed 5,000 hectares from 1961 to 1963, and then 5,700 hectares in 1965, respectively. There were major fluctuations that were observed around the trend. Trend line revealed varying areas of planted beans over the time period of 58 years from 1961 to 2017. The trend line was fluctuating from 1964 to 2017. Graphic and trend line of area planted are presented below in Figure 1.

Yield trend in beans
Trend line revealed a decrease of yield throughout 58 year time period (Fig.1). During this time-period, there were five peaks lying above the trend line. Below the trend line six troughs were experienced. Highest yield obtained was 3,760 mt/ha in 1984, followed by 2,840 mt/ha in 1997 and 2,480 mt/ha respectively. Lowest yield of 0,000 mt/ha in 2016 was released followed by 0,190 mt/ha in 2014 then 0,310 mt/ha respectively. Yield is said to be low when it is below 0.5mt/ha, and high at 0.5mt/ha and above. Therefore, there was low yield in 1988, 1990, 2002, 2003, 2004, 2009, 2010, 2015, and 2017 and in 2016 there was no yield at all.

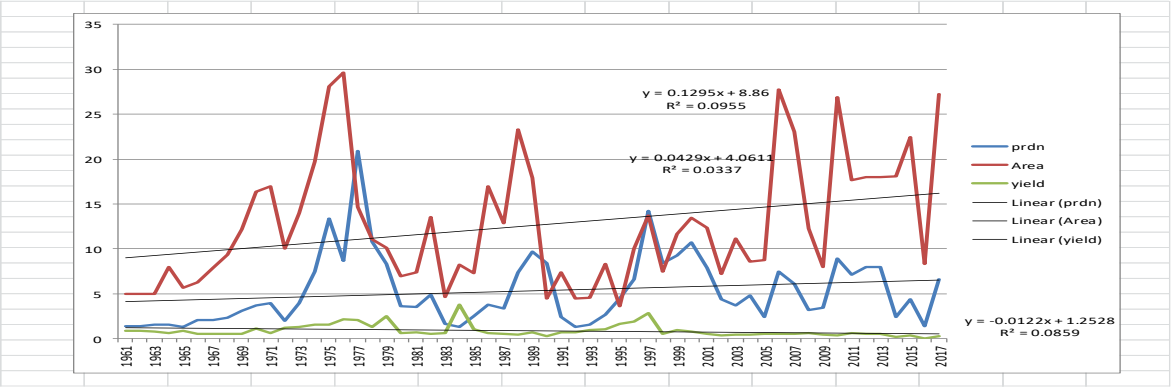

Fig.1. Production, area and yield trend curves and trend lines of beans

Beans production trend

The production of beans in Lesotho has shown an average increase over a period of 58 years from 1961 to 2017. There were peaks and troughs during this period which have been attributed to most climatic factors such as droughts, heavy rainfall, late rains fall, hail storm, snow, wind and outbreak of pests (Bureau of Statistics, 2014). All these natural calamities were not under control of bean farmers. The nature of heights and depths of peaks and troughs showed vividly that there was no control. Moreover, there were some factors which had a perceptible influence over bean production. Therefore, it would be of paramount importance to identify the factors and apply mitigating strategies.

The results of this study were consistent with the findings of (Robin, 2010) that conducted a study in South Africa in 1970 to 2013 and revealed a fluctuation of troughs and peaks in bean production. The beans grow optimally at temperatures between 18 to 24 °C. The maximum temperature during flowering should not exceed 30 ^{0}C (Schwartz, 1990). Production of beans in 2007 was 6.141 mt with maximum temperature of 32^{0}C and low rainfall of 1,663mm (Lesotho Meteological Service, 2015). In 2015, the beans experienced a lot of drought and this is proved by extremely high temperatures of 36.6^{0}C and minimum temperatures of 8.5^{0}C with the lowest rain fall in this trend of 10 years from 2005 to 2015 (Maredia, 2011).

The lowest maximum temperatures was seen in 2006 as 21^{0}C and production was 7,460 mt with the minimum temperatures of 7.9^{0}C. The lowest minimum temperature was seen in 2008 with 5.2^{0}C. However, the highest production 8.899 mt of was seen in 2010 with extremely high rainfall of 3,044mm.

Bean area trends

The area utilized for growing beans has increased over a period of 58 years from 1961 to 2017 as evidenced by trend line. However, there has been a fluctuation. The reason for fluctuation was the late rain fall, droughts prevalent in the beginning of the growing seasons (FAO Lesotho, 2015). The highest area planted beans in this trend of 10 years from 2005 to 2015 was in 2015, however, the farmers experienced drought in such big area of 22.488 ha with extremely high maximum temperatures of 36.6^{0}C and with the highest minimum temperature of 8.5^{0}C (Lesotho Meteological Service, 2017). Also, with the lowest amount of rainfall of 1,400mm. The lowest area planted beans was in 2009 with the coverage of 7.973 ha with average maximum temperature of 21.6^{0}C and minimum of 7.9^{0}C. There was a lot of rainfall of 2,100mm.

Yield trend in beans

The yield of beans also kept fluctuating throughout 58 years' time period with varying peaks and troughs. This could be attributed to less effort made by the farmers to improve productivity by applying modern technologies that will enhance productivity (Maredia, 2011). Several efforts were made by the Lesotho Government by initiating projects, subsidies, funding technical assistance but were short-lived terminating even before improvements were realized (Bureau of statistics, 2014). This was a futile effort to the Government. Yield is said to be poor when it is below 0.5mt/h, and well at 0.5mt/ha and above (Bureau of statistics, 2017). The maximum yield was obtained in 2008 with 0.67(mt/ha), with adequate rainfall of 1,824mm and average temperatures (max-22^{0}C and min-5.2^{0}C) (Lesotho Meteological Service, 2017). The lowest yield was obtained in 2015 with all conditions being extreme; maximum temperature of 36.6^{0}C and minimum temperature of 8.5^{0}C and rainfall of 1,400mm.

Factors affecting production

These various variables of factors affecting production have shown no significance in ANOVA. The highest coefficient of 0.663 of area in a constant of 0.262 was obtained to increase production per unit. This was followed by rainfall; when there was a constant of 0.001 one unit of rainfall would increase production by 0.176. The temperature (min) was followed; when there was a constant of 0.153 unit of temperature will increase production by 0.055. This was followed by yield; if there was a constant of 0.475 in one unit, yield would increase production by 0.095. The last variable was temperature (max); if there was a constant of 0.089, it means in a unit of maximum temperature production would increase by 0.189. The insignificance in ANOVA has proved that there is no difference amongst the factors affecting bean production. That is, all factors are required simultaneously. No factor is important than the other (Williams, 2017) in the University of Pretoria conducted the same study and obtained similar results.

Table 1: Analysis of variance for regression

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	38.488	5	7.698	1.281	0.396
Residual	30.057	5	6.011		
Total	68.545	10			

Regression analysis

Area – Regression shows that as area is increased by 1 unit, production increases by 0.663.

Constant is 0.262.

Yield – As yield is increased by 1 unit, production increases by 0.095. Constant is 0.0475.

Temperature (max) – As temperature is increased by 1 unit, production is increased 0.189. Constant is 0.089.

Temperature (min) – As temperature is increased by 1 unit, production is increased by 0.055. Constant is 0.153.

Rainfall- As rainfall is increased by I unit, production is increased by 0.176. Constant is 0.001.

Regression equation

The formulae below showed the regression coefficients of different factors of bean production as determined by regression table.

$yp=\mu+b1\ (X1) + b2\ (X2) + b3(X3)+ b4(X4)+ b5(X5)$

$yp=0.307+0.262(X1) +0.475(X2) +0.089(X3) +0.153(X4) +0.001(X5)$

Where;

yp= production of beans

μ=overall mean

b= regression coefficient (constant)

X= factors affecting production

Table 2. Regression coefficients of factors affecting bean production

Model	Constants	Regression Coefficients	Significance level.
(Constant)	0.307		0.979
Area	0.262	0.663	0.159
Yield	0.475	0.095	0.811
Temperature (max)	0.089	0.189	0.687
Temperature(min)	0.153	0.055	0.899
Rainfall(mm)	0.001	0.176	0.696

CONCLUSION AND RECOMMENDATION

Recently, farmers in Lesotho have been consistently obtaining low yields from beans. This has affected food production as well as considerably reducing incomes. The causes of these low yields are diverse and include low yielding varieties of seeds. The results in this study have

revealed that the factors influencing bean production did not significantly increase or decrease production.

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