International Journal of Agricultural Extension and Rural Development Studies
Vol.3, No.3, pp.61-66, July 2016
Published by European Centre for Research Training and Development UK (www.eajournals.org)

TREND OF WHEAT PRODUCTION IN LESOTHO AND ITS DETERMINANTS: FIVE DECADES AND BEYOND

Motlatsi E. Morojele and Mabataung S. Sekoli

The National University of Lesotho, Department of Crop Science, P.O.Roma. 180. Lesotho

ABSTRACT: *Wheat being the third most important cereal crop in Lesotho, after Maize and Sorghum, has been decreasing in production, area planted and yield. This decline has not been determined using statistical analysis. The objectives of the study were to (1) determine trend in wheat production, area planted and yield, (2) estimate regression coefficients of factors affecting wheat and (3) establish correlation coefficient of these factors. Time series data from 1961 to 2013 on total production of wheat, area planted, yield, rainfall and temperature were captured from FAOSTAT (2013). GENSTAT software was perform statistical analysis. The results revealed a dramatic decline in production, area planted and yield of 77%, 82% and 33.16%, respectively. Regression analysis revealed significant difference (p>0.01) among the regrsessors and each regressor had elasticity coefficient influencing wheat production. Correlation analysis showed that yield was highly correlated (r =0.6678) with area and moderately correlated with temperature (r =0.363) and rainfall (r = 0.2011).*

KEYWORDS: Wheat Trend, Lesotho, Production, Regression, Correlation

INTRODUCTION

Wheat is the third most important cereal crop in Lesotho, after maize and sorghum (Bureau of Statistics, 2014). It is grown mostly by smallholder farmers in the mountain areas under dryland conditions. Due to its cool climatic requirement, it is well suited to this area (Lesotho review, 2015). There are some pocket areas in the foothills and lowlands where it is also grown in winter season. There is a vast scope of extending wheat cultivation to other zones. Time for planting is variable among the ecological zones of Lesotho (Ministry of Agriculture, 2000). It is grown in the winter season using winter or facultative cultivars that require vernalization. Spring wheat grows very well vegetatively but does not give substantial yield because of lack of vernalization (Martin *et al*., 1976). The important factors affecting wheat productivity are late planting time, seeding rate, low soil fertility, poor seed-bed preparation and adverse climatic conditions during growing season (Central Bank, 2012; Bureau of Statistics, 2014; Lesotho review, 2015). The Extension services provided by the Government seem to be ineffective when assessing its impact on wheat productivity (World Food Programme, 2015). New wheat cultivars from South African Seed companies are evaluated by Department of Agricultural Research every other year, which upon success are released to the farmers together with proper agronomic practices (Douglas *et al*., 1995).

Nutritionally, wheat is a very rich source of proteins, vitamins, minerals, carbohydrates, and provides a balanced diet (Curtis *et al*., 2002). It is used mainly for bread-making in many house-holds. Other wheat products are muffings, dublins and cakes (Curtis *et al*., 2002). In the past, wheat products were consumed by urban and peri-urban dwellers on special occasions or festive seasons but now Basotho have changed their eating habits having bread almost every day in both urban and rural areas alike. This has increased the demand for wheat produced and imported into the country (Food and Agriculture Organization, 2007). At the same time, the

Print ISSN: ISSN 2058-9093 Online ISSN: ISSN 2058-91

national production of wheat and land put to it seem to be declining even though no scientific and analytical approaches have been employed to confirm this (Rosenberg and Weisfelder, 2013). It was therefore with this reason that the study had been undertaken. The specific objectives of the study were to (1) determine the trend in wheat production, area planted and yield, (2) estimate regression coefficients of factors affecting wheat and (3) to establish correlation coefficient of key these factors.

METHODOLOGY

Study area

The study 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 27^0E and 30^0E, latitude 28^0S and 31^0S, and altitude of 1400 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 (max and min in both seasns) in summer and -5^0C in winter with snowfall in the mountain and foothill areas. Lowland may occasionally experience snowfall.

Data collection and analysis

The study covered a period of 53 years from 1961 to 2013. Time series data on total production of wheat, area planted, yield, rainfall and temperature 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 wheat 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.

The regression model was stated using the equation:

$$Pw = \beta + \beta_1(X_1) + \beta_2 (X_2) + \beta 3(X_3) + \beta 4 (X_4) + \varepsilon$$

Where Pw = Production of wheat, X_1 = Area, X_2 =rainfall, X_3 = temperature, X_4 =yieldε= error term.

RESULTS AND DISCUSSION

Production trend

Wheat production trendline revealed a sharp decline of 57 5400 tons from 1961 to 13 000 tons in 2013 resulting in a decrease of 77%. During this time-period under study, eight peaks and eight troughs were observed along the trendline. From 1960 to 1978, there was a fluctuation at a high production level ranging between 57 000 tons and 61 000 tons, which was followed by a sudden drop to 14 462 tons in 1982 which continued until 1995 when production was 10 603 tons. This was followed by another sharp increase in 1997 to 33 722 tons. Two years drop in

Print ISSN: ISSN 2058-9093 Online ISSN: ISSN 2058-91

production of 15 426 tons in 1999 to 2000 was realized, followed by a sharp increase to 50 5755 tons in 2001, after which production dropped to 3 720 tons in 2008. There was a slight increase in the production to 20 119 tons in 2010, after which there was a decline to 10 516 in 2012. Trendline and production curve are depicted in figure 1. These results were consistent with the findings of Breitenbach and Fenyes (2000) who found the declining wheat trend from 2,4 million tons to 1.2 million tons from 1993 to 2000. Similarly, Beyene *et al*. (1990) observed a decline in wheat production grown in Ethiopia over 20 years from 1961 to 1981, after which it increased by 3%.

Area trend

Similarly, the trend in area planted to wheat decreased dramatically from 39 119 hactares (ha) in 1962 to 7 000 ha in 2013, resulting in a decrease of 82%. From the time-period 1962 to 1973, there was a steady decline from 39 119 ha to 36 000 ha, followed by gradual increase to 33 629 ha in 1979, after which gradual reduction was experienced until 2013 where 7 319 ha was planted. The largest area of 33 629 ha was planted in 1979 while the smallest area of 4 200 was planted in 1999. Breitenbach and Fenyes (2000) found a dramatic decline in the area planted wheat from 1,2 million hactares to 560,000 hactares between the years 1993 and 2000. Beyene *et al*. (1990) reported a decline of 3.56% in an area put to wheat from 1961 to 1981 in Ethiopia.

Yield trend

The yield trendline from 1960 to 2013 revealed a steady decrease of 33% from 0.220 to 0.0731 tons of wheat, respectively. Two yield peaks were observed in 1991 and 2001 where yield rose to 0.684 and 0.169 tons. Three troughs of low yield occurred in 1971 amounting to 0.1934 tons, 1996 amounting to 0.1138 tons and in 2007 with 0.08687 tons. Similarly, a dramatic decrease from 3.5 ton ha^{-1} to 2.5 ton ha^{-1} in yield from 1993 to 2000 was also observed in South Africa (Breitenbach and Fenyes, 2000). Beyene *et al.* (1990) reported a decrease in wheat yield in Ethiopia from 5.4 ton ha^{-1} to 3.3 ton ha^{-1} during time-period 1961 to 1981. However, this decline in wheat yield was followed by a sharp increase in the productivity of wheat. In Bangladesh, wheat yield declined from 1998 to 2004. This implied that at certain time-period in any country there will be a decline in wheat yield which may take varying number of years depending on the cause. This decline is always followed by an increase which could be considered as a compensatory growth.

Print ISSN: ISSN 2058-9093 Online ISSN: ISSN 2058-91

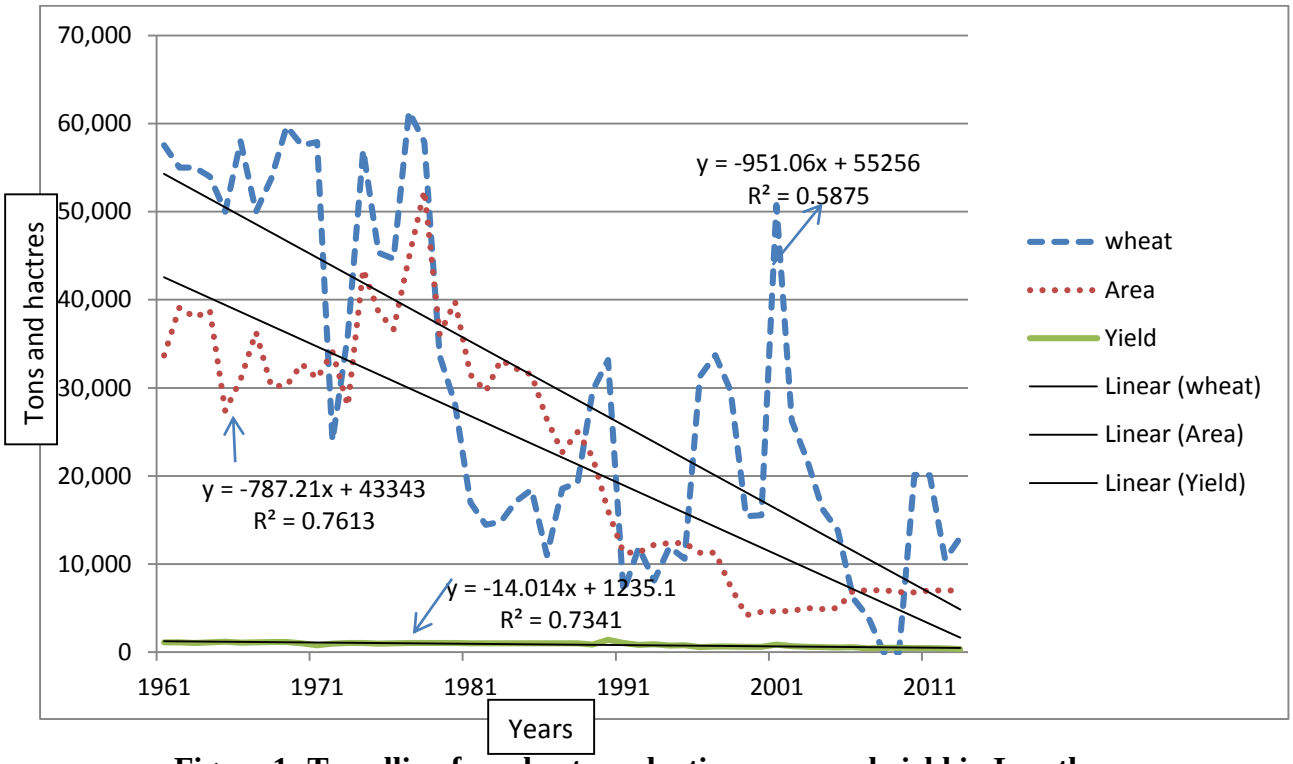

Figure 1: Trendline for wheat production, area and yield in Lesotho.

Regression analysis

Analysis of variance for regression (Table 1) shows a highly significance (P>0.01) difference among the area where wheat was grown, wheat yield per hactare (productivity), rainfall and temperature considered as regressors. A constant for regression model was 1113 ton ha^{-1}, while the elasticity coefficients for area, rainfall, yield and temperature were 0.0427, 4.26 and 4.06, respectively (Table 2). This meant that as an area was increased by one unit, production increased by 0.0427 units. Similarly, as rainfall was increased by one unit wheat production was increased by 4.26 units. One unit of temperature increased the production of wheat by 4.06 while one unit of yield increased production by 1.45units. The regression model was stated using the equation:

$$Pw = \beta + 0.0427(X_1) + 4.26\ (X_2) + 4.06\ (X_3) + 1.45\ (X_4) + \varepsilon$$

Where Pw = Production of wheat, X_1 = Area, X_2 =rainfall, X_3 = temperature, X_4 =yieldε= error term.

Table 1: Analysis of variance for regression analysis

Source of variation	df	Sum of squares	Mean square	Calculated F	Table F
Regression	3	569754	189918	617	0.004
Residual	19	585031	30791		
Total	22				

Print ISSN: ISSN 2058-9093 Online ISSN: ISSN 2058-91

Table 2: Regression coefficients of area, rainfall, temperature and yield

Parameters	Regression coefficients	Standard error	t-value (calculated)	t-value (table)
Constant	1113	1338	0.83	0.416
Area	0.0427	0.0130	3.28	0.04
Rainfall	4.26	3.22	1.32	0.201
Temperature	4.06	92.1	0.44	0.664
Yield	1.14	32.4	6.98	1.76

Many studies were conducted to estimate regression coefficients of independent variables (regressors) over the dependent variable (regressant). Analysis of variance was performed to determine if there was a significant difference among the regressors. Breitenbach and Fenyes (2000) used area, yield and production to estimate regression coefficients of wheat grown in South Africa and obtained significant regression analysis. Similarly, Bezabeh *et al*. (2015) used multiple regression to estimate elasticity coefficients of area put to wheat and yield of wheat. Regression coefficients of both area and yield of wheat were highly significant. The results also concurred with findings of Karim *et al*. (2005) who obtained significant regression analysis of wheat grown in Bangladesh using time-series data.

Correlation Coefficient

Correlation analysis (Table3) showed that yield was highly correlated (r =0.6678) with area and moderately correlated with temperature (r=0.363) and rainfall (r=0.2011). Temperature was negatively correlated with area (r = -0.5105) and rainfall (r = 0.1871). No correlation existed between area and rainfall. There was low correlation between rainfall and temperature (r = 0.1871). The correlation among yield, area, temperature and rainfall implied that if they were all increased production would have increased as well with area having a perceptible influence followed by temperature and rainfall. Any factors that get reduced or decrease can affect others negatively. Dehgahi *et al.* (2014) showed a strong correlation between temperature, rainfall and grain yield using data from 1993 -2008. Similarly, Pal *et al.* (2013) applied seasonal temperature and rainfall forecast for wheat production in Palampur, Himachal and Pradesh, in India. and found high correlation between rainfall, temperature and wheat yield.

Table 3: Correlation among area, yield, rainfall and temperature

	Yield	Area	Rainfall
Area	0.6678		
Rainfall	0.2011	0.0065	
Temperature	0.3636	-0.5105	0.1871

CONCLUSION

National wheat production and area planted have declined dramatically over the past 53 years by an average of 82% even though there were some dips and peaks in between. Yield remained constant over the period understudy. Regression analysis revealed significant influence among the key factors that determine production of wheat in Lesotho being rainfall, temperature and yield. Correlation analysis showed that yield was highly correlated with area and moderately

Print ISSN: ISSN 2058-9093 Online ISSN: ISSN 2058-91

correlated with temperature and rainfall. Thus indicating the best prospect for yield increase would be increase in area under wheat production.

REFERENCES

Bezabeh, E., Haregewoin T., Giorgis D. H., Fitsum D. and Baye B. 2015. Change and growth rate analysis in area, yield and production of wheat in Ethiopia. Research Journal of Agriculture and Environmental Management.4(4). 189-181.

Beyene, H., Franzel S., and Mwangi W. 1990. Constraints to increasing wheat production in Ethiopia' small-holder sector. Sixth regional workshop for Eastern, Central and Southern Africa. CYMMYT. Mexico. pp284-293.

Breitenbach, M.C. and Fenyes T.I. 2000.Maize and Wheat production trends in South Africa in a Deregulated environment. Agrekon, 39: 292-312.

Bureau of Statistics, 2014.Lesotho Agricultural Situation Report. BOS, Maseru.

Central Bank, 2012. Economic review: No.139. www.centralbank.org.ls/publication.

Curtis, B.C., Rajaram, S and Macpherson, H. G. 2002. Bread wheat: Improvement and production. FAO, Rome.

Dehgahi,R., Joniyas,A. and Latip, M.D. 2014. Rainfall Distribution and Temperature Effects on Wheat Yield in TorbateHeydarie. International Journal of Scientific Research in Knowledge. .2: 121-126.

Douglas, T.G., Payne, T.S. and Abdalla, O.S. 1995. The ninth regional wheat workshop. CIMMYT, Ethiopia.

Food and Agriculture Organization, 2007. FAO/WFP crop and food suplly assessment mission to Lesotho. FAO, Rome.

Karim, R., Awal M. and Akter M. 2010.Forecasting of wheat production in Bangladesh. Bangladesh Journal of Agricultural Research 35(1):17-28.

Lesotho review, 2015. An overview of the Kingdom of Lesotho's economy: 2015 edition. Wade Publication CC., Durban.

Martin, J.H., Leonard, W.H. and Stamp, D.L. 1976. Principles of Field Crop Production. Collier MacMillan, New York.

Ministry of Agriculture, Cooperatives and Marketing, 2000.Annual report 1999/2000.MACM. Maseru.

Pal, R.K., Sehgal, V.k., Misra, A.K. and Ghosh, K. 2013. Application of seasonal temperature and rainfall forecast for wheat prediction for Palampur, Himachal and Pradesh. Journal of Agriculture and Food Science Technology.4(5) 453 – 460.

Rosenberg, S. and Weisfelder, R.F. 2013.Historical dictionary of Lesotho. Scarecrow, Maryland.

World Food Programme, 2015.Lesotho vulnerability assessment survey. www.wfp.org/countries/Lesotho/overview.

Print ISSN: ISSN 2058-9093 Online ISSN: ISSN 2058-91