

## Growth rate, instability and trend analysis of Potato industry in Lesotho.

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### Article History

Received: 25/05/2025

Accepted: 03/06/2025

Published: 05/06/2025

### Vol – 4 Issue –6

PP: - 10-17

### Abstract

Potato has been grown in Lesotho by farmers for home consumption and surplus sold. Since potatoes were produced, no study has been undertaken to determine progression of potato industry. Therefore, objectives of the study were to: (1) estimate growth rate and instability in potato production, productivity and area grown, (2) determine trends in potato production, export and import volumes, value and price. Time series data were collected from Index box and Koenema. Data were captured using Microsoft excel, after which growth rate, instability and trend analysis were performed. Statistical package for social sciences was employed to draw linear graphs for afore-mentioned parameters. Results revealed compounded growth rate of 34.94% in potato production from 2007 to 2023, while annual growth rate fluctuated around mean of 116,310 kg with variance of 196.95. Mean yield of potato in a hectare from 2007 to 2016 was 17,000 kg with variance of 0.37. Over 16 years of potato production, there was infinitesimal difference among the years in yield. Compound growth rate in yield was 0.57%. Mean area of potato over study period was 68.1ha with variance of 0.40. Compound growth rate in area was 26.41%, while annual growth rate was erratic above the mean, though few were in negative territory. Mean export volume of potatoes over 16 years was 1,490 kg with variance of 0.94%. Annual growth rate was erratic, running above and below the mean in unpredictable manner. Compound growth rate was 746.31%. Mean of export value was US\$4,580 with variance of 3.79%. Annual growth rates of export values were erratic, mostly in the positive territory. Compound growth rate revealed 102.83%.

Differences among export values were infinitesimally with an exception in 2009, 2012 and 2017. Annual growth rate of export values was erratic fluctuating with highest being 447.06% in 2017 and lowest of -10% in 2008. Compound growth rate revealed 102.83%. The study revealed stagnant potato industry with little growth.

**Keywords:-** Potato, trend analysis, growth rate, import, export, Lesotho.

## INTRODUCTION

Potato (*Solanum tuberosum* L.) is the only tuber crop adaptable in Lesotho with some areas producing high yield particularly agro-ecological zone of foothills (Molahlehi et al., 2013; Bureau of Statistics, 2022). It has been grown by small-holder farmers for home consumption in the rural areas and surplus is sold in the neighborhoods to generate income for the family (Marake, 2021). Nonetheless, farmers in the lowlands produce potatoes in large quantities and sell to the retailers, hospitals, supermarkets, prisons, schools and restaurants (Leete et al., 2013). They produce them using external inputs such as certified disease-free and high yielding cultivars, inorganic fertilizers, pesticides and farm machinery for field operations (Marake, 2021). Subsequently, productivity is high, resulting in increased national production that reduces imported volume of potato into the country. Lesotho National Farmer' Union (2021) has made concerted efforts to increase production with donor agents and agricultural projects by identifying most suitable areas in the country in terms of environmental conditions, designating seed

production and multiplication areas, providing extension service particularly for table-ware production (Africa Press-Lesotho, 2019). The areas designated for potato seed production included among others; Mphaki, Matelile, Marakabei, Mohale and Ha Lejone, all located in the foothills of Lesotho (Kolane, 2021). Subsequent to these efforts, the enrollment of farmers into the potato industry has increased swiftly resulting in the formation of farmer's association at both district and national level being formed to organize value chain. Despite interventions, productivity, area under which they are produced and national production are speculated to be low necessitating rigorous policies and regulations to guide production. No studies have been conducted to determine the progression of potato industry since various interventions from donor agents. Therefore, objectives of the study were to: (i) estimate growth rate and instability in potato production, productivity and area grown, (ii) determine trends in potato production, export and import volumes, value and price.

## MATERIALS AND METHODS

### Study area

The study was carried out in Lesotho which is situated in Southern Africa occupying an area of 33,000 km<sup>2</sup>, which approximately 40% is arable land and 60% rangeland. The country is divided into four agro-ecological zones, namely; lowlands, foot-hills, mountain and Orange River valley. Agro-ecological zones are based on climatic conditions, soil type, altitude, rainfall pattern and duration of growing season. The coordinates of Lesotho are; latitude is 29.61'000 South while longitude 28.23'360 East. The altitude ranges between 1100m and 3500m above sea level. The country is entirely surrounded by the Republic of South Africa. It has a population of 2.2 million (Bureau of Statistics, 2022), of which 70% depends on agriculture for their livelihood. It is mostly practiced in the rural area where old traditional methods are still adopted by subsistence farmers and very small number of emerging commercial farmers have embarked on modern farming practices and associated technologies.

### Climate

Lesotho has a temperate climate characterized by warm summer with temperature ranging from 22°C to 33°C with few incidences of rising to 39°C. Winter season is very cold with freezing temperature falling to -7°C accompanied by shallow to deep snowfall in the lowlands and highlands, respectively.

The mean annual rainfall is approximately 750mm with maximum of 1200mm and minimum of 400mm. Rainfall commences in October and increases gradually until it reaches a peak in February, after which it declines faster and ends in April. May, June and July are dry seasons.

### Data collection

The study used time series data collected from Bureau of Statistics in Lesotho, website of Knoema and inbox which were consistent. The data covered a time-period of 16 years spanning from 2007 to 2022 on potato production, area grown potatoes, yield, import volume and price, export volume and price, export and import values, export and import price parity.

### Data analysis

Time series data collected were captured and stored in the Microsoft excel spread sheet (version 25), after which growth analysis in percentage, trend-lines, means, standard deviation, variance, stability index were performed. Statistical package for social sciences (SPSS) was employed to draw the linear graphs for afore-mentioned parameters. Growth rate was compared among the years to determine deceleration, stagnancy or acceleration in potato production. Instability index together with coefficient of variance were calculated for production, exportation, importation and price parity.

Using the same data spanning over 16 years, linear graphs and trend lines were drawn to determine long term performance of pea production. Both regression equation and coefficient of determination were calculated.

Formula applied in the study;

- (a) Mean = Summation of observation/ number of observation (15 years)

$$\bar{X} = \frac{\sum X}{N}$$

where;

$\sum$  = Total of observations/

N = Number of years

- (b) S.D= Standard Deviation of area/production/yield

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

where;

X = observations

n = number of years

- (c) Variance equation

$$\sigma^2 = \frac{\sum (X - \mu)^2}{N}$$

where;

$\sum$  = total of observation

X = Observations

N = number of years

$\mu$  = population mean

- (d) Coefficient of variation

$$CV (\%) = \left( \frac{\text{Standard deviation}}{\text{Mean}} \right) \times 100$$

Formula for standard deviation in (b) above.

- (e) Compound annual growth rate

$$CAGR = \left( \frac{V_f}{V_i} \right)^{\frac{1}{n}} - 1$$

V<sub>f</sub>=final value,

V<sub>i</sub> = initial value,

n= number of years

- (f) Annual Growth Rate

AGR = value in *t*th year - value in (t-1)h year / value in (t-1)th year

- (g) Linear regression

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

## RESULTS AND DISCUSSION

Data collected were analyzed and below is the interpretation presented in a narrative, graphical and tabular form for better comprehension and visualization.

### Growth rate of potato production, yield and area

The mean of potato production over a period of 16 years being studied was 116,310 tons with a variance of 196.95. There was an increase from 91,000 tons to 128,700 tons. The highest potato production experienced was 131,000 tons which occurred in 2014, while the lowest potato production obtained was 91,000 kg in 2009. Out of 16 years of study, the production below and above the mean were observed in seven and eight years, respectively. No single year share the similar amount, though production in some years maybe in close proximity such as in 2011 and 2020 where 112,000 kg and 112,700 kg were achieved, respectively. Growth rate in production was highest in 2011 recording 13.13% and lowest in 2020 registering -11.26%. Compound growth rate during 16year period was 34.94%, with some years falling in negative territory while other fell in positive territory (Table 1). These results were found consistent with findings of Siddique et al (2015) who discovered that the mean production of potato in Bangladesh was 8.4 million tons which increased by 30 – 40 ton from 2005/6 to 2000/11 with high and lows between the years. Similarly, Kumar et al (2021) recorded a significant growth rate in potato production from 9,7 million mt in 1981 to 53 million mt in 2019. Over a period of 20 years under studied, world potato production increased modestly by 16.1% to 374.7 million tons. Africa and South Africa raised potato production by 106% to 27.1 million tons and 49% to 2.5million tons, respectively (National Agricultural Marketing Council, 2017).

The mean yield of potato in a hectare over the studied from 2007 to 2016 was 17.11ton, with a variance of 0.37. The highest yield obtained was 18,000 kg ha<sup>-1</sup> in 2016 with the lowest yield recorded being 16,000 kg ha<sup>-1</sup>. Over 16 years of potato production, there was infinitesimally small differences among the years, thus stable. The compound growth rate in yield was recorded 0.57% (Table 1). Conversely, the study conducted by Siddique et al (2015) revealed a moderate increase in yield per hectare from 13,81 mt in 2005/6 to 18.1 mt per hectare in 2010/11. Similarly, a study conducted in Ethiopia by Hirpa et al. (2010) who revealed an increase in potato yield from 10 ton in a hectare to 18 tons in a hectare within a time-period of 15 years. Globally, potato yield increased modestly by 30% to 21.1 ton/ha, 42% to 14.9 tons in Africa and 19% to 37.8 tons' ha in South Africa. South Africa was ranked the highest county in yield/ha surpassing Africa and global averages. Small holder farmers produced 10-20tons/ha, while commercial farmers obtained an average of 47 ton/ha (Lungelo, 2024).

The mean area planted potato in a hectare during the study from 2007 to 2016 was 68.1 ha, with a variance of 0.63. The highest area planted was 73 ha in 2015 with the lowest yield recorded being 56 ha. Over 16 years of potato production, there was infinitesimally small differences among the years, thus stable. The compound growth rate in the area was recorded 26.41% (Table 1). In Bangladesh et al., (2013) reported an average increase in area planted to be 20% over 5 years. Siddique et al (2015) also found the area under potatoes

had increased in 2005/6 from 301,000ha to 460, 000ha in 2010/11. Hirpa et al (2010) in Ethiopia observed an increase of 31% over a period of 15 time in the area under potato production. Conversely, world potato production declined by 10% from 19.8 million hectares in 2000 to 17.7 million hectare in 2022. Nonetheless, Africa and South Africa increased their areas by 45% to 1.8 million hectares in 2022 and 24% to 66,800 hectares in 2022, respectively (Department of Agriculture, Land Reform and Rural Development, 2023).

**Table 1: Production, yield and area growth rate of potato**

| Year                         | Production ('000) |                 | Yield (ton) |                 | Area harvested (ha) |                 |
|------------------------------|-------------------|-----------------|-------------|-----------------|---------------------|-----------------|
|                              | Mean Production   | Growth Rate (%) | Mean Yield  | Growth Rate (%) | Mean Area           | Growth Rate (%) |
| 2007                         | 93.0              |                 | 16.6        |                 | 56                  |                 |
| 2008                         | 96.5              | 3.76+           | 16.7        | 0.60+           | 58                  | 3.57+           |
| 2009                         | 91.0              | 5.70-           | 16.0        | 4.19-           | 57                  | 1.72-           |
| 2010                         | 99.0              | 8.79+           | 16.5        | 3.13+           | 60                  | 5.26+           |
| 2011                         | 112.0             | 13.13+          | 16.5        | 0               | 68                  | 13.3+           |
| 2012                         | 115.0             | 2.68+           | 16.4        | 0.61-           | 70                  | 2.94+           |
| 2013                         | 125.0             | 8.70+           | 17.4        | 6.10+           | 72                  | 2.86+           |
| 2014                         | 131.5             | 5.20+           | 17.1        | 1.72-           | 72                  | 0               |
| 2015                         | 123.0             | 6.46-           | 16.9        | 1.17-           | 73                  | 1.39+           |
| 2016                         | 126.5             | 2.85+           | 18.0        | 6.51+           | 70                  | 4.11-           |
| 2017                         | 128.7             | 1.74+           | 17.7        | 1.67-           | 73                  | 4.29+           |
| 2018                         | 126.1             | 2.02-           | 17.5        | 1.13-           | 72                  | 1.37-           |
| 2019                         | 127.0             | 0.78+           | 17.7        | 1.14+           | 72                  | 0               |
| 2020                         | 112.7             | 11.26-          | 17.7        | 0               | 72                  | 0               |
| 2021                         | 126.8             | 12.51+          | 17.6        | 0.57-           | 72                  | 0               |
| 2022                         | 127.1             | 0.24+           | 17.6        | 0               | 72                  | 0               |
| Mean                         | 116.31            |                 | 17.11       |                 | 68.1                |                 |
| Standard deviation           | 14.03             |                 | 0.61        |                 | 0.63                |                 |
| Variance                     | 196.95            |                 | 0.37        |                 | 0.40                |                 |
| Coefficient of variation (%) | 12.06             |                 | 3.57        |                 | 9.25                |                 |
| Compounded growth rate       |                   | 34.94           |             | 6.42            |                     | 26.41           |

### Growth rate of export, import volumes and values

Mean export volume of potatoes over a time-period of 16 years was 1,490 kg with a variance of 0.94%. The highest volume was 3,600 kg in 2014, while the lowest was 300 kg in 2014. Out of 16 years of study, eight years of the export volume exceeded the mean, while the other eight years were below the mean. The highest annual growth rate of export volume of 77% was experienced in 2020 and lowest was -525% in 2017. The growth rate over the years was very erratic running above and below the mean in an unpredictable manner. The compound growth rate was 746.31% with eight export volumes falling in the negative territory, while other eight were in the positive territory (Table 2). In South Africa, export volume showed an increase of 6.1% to 181,546 tons in 2021, while Egypt export volume decreased by 33.9% to 472,451 tons in 2021 with great fluctuations within 10 year time-period (Trade Map, 2023). In Lesotho, mean of export value was US\$4,580 with a variance of 3.79% over 16-year period of study. The highest and lowest values were US\$10,000 and US\$1,200, respectively. The differences among the export values during the infinitesimally small with an exception in 2009, 2012 and 2017. The frequency of similar export values observed were US\$2,000; US\$1,800; US\$9,300 and US\$1,700 in the year 2007; 2021; 2008 ;2022; 2009; 2017; 2014 and 2016, respectively. Growth rate of

export values was very erratic fluctuating with the highest being 447.06% in 2017 and the lowest of -10% in 2008. The eight export value growth rates were in the negative territory while other eight were positive territory. Compound growth rate revealed 102.83% (Table 2). In South Africa, the potato export increased by 4.7% year on year to R758 million in 2021 to 2022, which was higher than an average of five years 10.7% amounting to R717 million (Trade Map, 2023). Africa is exporting 96% of world potato production, of which Southern African Development Community members export 33% of 96%. Middle East countries account for 3% only.

Egypt is the main potato exporter in Africa, followed by South Africa, then Ethiopia, Morocco and Kenya (Department of Agriculture, Land Reform and Rural Development, 2023).

#### Import volume and value

The mean import volume into Lesotho was 5,220 tons with a variance of 15.46. The highest import volume experienced was 11,800 tons, 10,500 tons and 10,100 ton in 2015, 2018 and 2017, respectively. The lowest volume was 200 ton obtained in 2007 and 2008. The highest annual growth was 466.67% observed in 2010, which was exceptional, while the lowest rate was in 2019 with -29.52%. Compound growth rate was 756.75% (Table 2). In South Africa, potato import was 14,000 tons in 2023, which exhibited a fast increase from 50,000 tons in 2018. There was a sharp peak of 18,000 tons in 2016, followed by a sudden drop of 70,000 tons in 2017, and then 2018 with 50,000ton (Nkunjana and Ntombela, 2023).

The mean import value over 16 years was US\$2,880 with variance of 6.76. Highest value was obtained in 2017 with US\$3,400 ton and lowest US\$100. Initially, there was an increase which in the later years levelled off. The highest annual growth rate was observed in 2010 recording 350%, followed by 100% in 2009, lowest value was -12.90 experienced in 2016. Compound growth rate was 603.47% (Table 2). The top importers of potatoes are Belgium (US\$524.4 million) with an increase of 9.87%, United States of America (US\$410 millions), Spain (USD 343 million, Netherlands (USD 315 million) and Germany (USD 249million) with growth rate of 3-10% over 10 year period (National Agricultural Marketing Council, 2023).

**Table 2. Export, Import and growth rate**

| Year                         | Export            |                 |                   |                 | Import            |                 |                   |                 |
|------------------------------|-------------------|-----------------|-------------------|-----------------|-------------------|-----------------|-------------------|-----------------|
|                              | Volume ('000 ton) | Growth Rate (%) | Value ('000 US\$) | Growth Rate (%) | Volume ('000 ton) | Growth Rate (%) | Value ('000 US\$) | Growth Rate (%) |
| 2007                         | 3.2               |                 | 2.0               |                 | 0.2               |                 | 0.1               |                 |
| 2008                         | 2.8               | 12.5-           | 1.8               | 10-             | 0.2               | 0.00            | 0.1               | 0.00            |
| 2009                         | 1.4               | 50-             | 9.3               | 416.7+          | 0.3               | 50.00+          | 0.2               | 100.00+         |
| 2010                         | 1.1               | 21.4-           | 6.6               | 29.03-          | 1.7               | 466.67+         | 0.9               | 350.00+         |
| 2011                         | 0.6               | 0.46-           | 3.2               | 51.52-          | 3.2               | 88.24+          | 1.5               | 66.67+          |
| 2012                         | 2.0               | 233.0+          | 10.0              | 212.5+          | 5.3               | 65.63+          | 2.8               | 86.67+          |
| 2013                         | 2.5               | 25+             | 1.2               | 88.0-           | 5.2               | 1.89+           | 2.6               | 7.14-           |
| 2014                         | 0.3               | 88-             | 1.7               | 41.7+           | 7.8               | 50.00+          | 3.3               | 26.92+          |
| 2015                         | 0.5               | 66+             | 2.3               | 35.29+          | 11.8              | 51.28+          | 3.1               | 0.06-           |
| 2016                         | 0.4               | 20-             | 1.7               | 26.09-          | 9.2               | 22.03-          | 2.7               | 12.90-          |
| 2017                         | 2.5               | 525+            | 9.3               | 447.06+         | 10.1              | 9.78+           | 3.4               | 25.93+          |
| 2018                         | 0.4               | 84-             | 1.5               | 83.87-          | 10.5              | 3.96+           | 3.3               | 2.94-           |
| 2019                         | 0.8               | 100+            | 2.5               | 66.67+          | 7.4               | 29.52-          | 2.3               | 30.30-          |
| 2020                         | 1.5               | 87.5-           | 3.4               | 36.00+          | 6.3               | 14.86-          | 2.2               | 4.35-           |
| 2021                         | 3.5               | 133.3+          | 2.0               | 41.18-          | 9.6               | 52.38+          | 2.1               | 4.55-           |
| 2022                         | 3.6               | 2.87+           | 1.8               | 10.00-          | 8.0               | 16.67-          | 2.3               | 9.52+           |
| Mean                         | 1.49              |                 | 4.58              |                 | 5.22              |                 | 2.88              |                 |
| Standard deviation           | 0.94              |                 | 3.79              |                 | 3.93              |                 | 2.66              |                 |
| Variance                     | 0.90              |                 | 14.36             |                 | 15.46             |                 | 6.76              |                 |
| Coefficient of variation (%) | 63                |                 | 84.22             |                 | 75.29             |                 | 92.36             |                 |
| Compound growth rate         |                   | 746.31          |                   | 102.83          |                   | 756.75          |                   | 603.47          |

#### Growth rate of export and import prices, and parity

The mean of export prices from 2007 to 2022 was US\$458.563 with a variance of 28,469.81. Highest and lowest export price were US\$686 and US\$172 in 2007 and 2021, respectively. A steady, general and increasing trend was observed over the period with unequal intervals. In nine subsequent years, the export prices were above mean of export price. Conversely, in seven subsequent years, export prices were below the mean price. Highest annual growth rate of 13.37% in export price was expressed in 2022, with the lowest being -26.92%. The growth rate in export prices were inconsistent with irregular intervals. In ten years, the growth rates were in the negative territory translating into a decline. It is only in five years that export prices were in the positive territory leading to an increase. Compound growth rate of export prices was -92.71% showing a decline in the export price (Table 3). World-wide, export price increased by 100% from US\$166.5 to US\$333 per ton from 2010 to 2022. Similarly, Africa experienced an increase of 58% from US\$ 198.9 to US\$ 336 per ton, while South Africa also realized a rise of 16% from US\$218.4 to US\$260 per ton from 2010 to 2022 (Department of Agriculture, Land Reform and Rural Development (2023). The trends in the increase of export prices in the afore-mentioned areas were consistent with those of Lesotho as indicated above.

The mean of import price for potato of over 16 years was US\$378.83 with a variance of 34,727.35. Highest and lowest import prices were US\$660 in 2009 and US\$280 in 2022, respectively. The import prices declined gradually from US\$580 in 2007 to US\$280 in 2022 with an unequal interval, though there was an exception of US\$660 in 2009. An import price of US\$340 was offered in three years, namely; 2017, 2020, and 2021. In eight years, import prices were below the mean price, while in the other eight years were above the mean price. Nine negative growth rates were observed, while five were exhibited a positive growth. The annual import



prices were fluctuating from one year to the other. Compound growth rate revealed a -80.84% translating into a decline. The mean parity price was US\$92 with the highest recorded US\$216 and lowest US\$2. Similarly, price parities were volatile, unpredictable and fluctuating. Nine parity prices were above the mean, while seven were below. Regarding parity percentage, there was a fluctuation between -18.42% and 31.99% with seven in the negative territory and eight in the positive territory (Table 3). Globally, import prices advanced at a relatively rapid rate reaching 86% to US\$349 per ton, which is substantially higher than export price. In Africa, potato price rise by 53% to US\$478 per ton, while South Africa realized an increase of 209% to US\$ 489 per ton. Generally, there was an increase in potato price during the time understudy though the rate of increase differed greatly with South Africa being in the higher side (Lungelo, 2024).

World-wide, export price increased by 100% from US\$166.5 to US\$333 per ton from 2000 to 2022. Similarly, Africa experienced an increase of 58% from US\$ 198.9 to US\$ 336 per ton, while South Africa also realized a rise of 16% from US\$218.4 to US\$260 per ton from 2000 to 2022 (Department of Agriculture, Land Reform and Rural Development, 2023). The trends in the increase of export prices in the aforementioned areas were consistent with those of Lesotho as indicated above.

**Table 3. Export and Import prices and parity**

| Year                 | Export price (US\$/ton) | Growth rate (%) | Import price (US\$/ton) | Growth rate (%) | Parity (price /US\$) | Parity (%) |
|----------------------|-------------------------|-----------------|-------------------------|-----------------|----------------------|------------|
| 2007                 | 686                     |                 | 580                     |                 | 106.00               |            |
| 2008                 | 631                     | 8.00+           | 540                     | 6.90-           | 91.00                | 1.10       |
| 2009                 | 655                     | 3.80+           | 660                     | 22.22+          | 5.00                 | 18.42-     |
| 2010                 | 647                     | 1.22-           | 520                     | 21.21-          | 127.00               | 19.99+     |
| 2011                 | 630                     | 2.63-           | 460                     | 11.50-          | 170                  | 8.87+      |
| 2012                 | 493                     | 21.74-          | 535                     | 16.30+          | 42                   | 5.44-      |
| 2013                 | 487                     | 1.21-           | 470                     | 12.15-          | 17                   | 10.94-     |
| 2014                 | 507                     | 4.11+           | 420                     | 10.64-          | 87                   | 6.53+      |
| 2015                 | 476                     | 6.11-           | 260                     | 38.10-          | 216                  | 31.99+     |
| 2016                 | 448                     | 5.88-           | 290                     | 11.54+          | 158                  | 5.66-      |
| 2017                 | 373                     | 16.74-          | 340                     | 17.20+          | 33                   | 0.46-      |
| 2018                 | 397                     | 6.43+           | 330                     | 2.94-           | 67                   | 3.49+      |
| 2019                 | 312                     | 21.41-          | 310                     | 6.06-           | 2                    | 15.35-     |
| 2020                 | 228                     | 26.92-          | 340                     | 9.68+           | 112                  | 17.24+     |
| 2021                 | 172                     | 24.56-          | 340                     | 0.00            | 168                  | 24.56+     |
| 2022                 | 195                     | 13.37+          | 280                     | 17.64-          | 85                   | 4.27-      |
| Mean                 | 458.563                 |                 | 378.83                  |                 | 92                   |            |
| Standard deviation   | 168.73                  |                 | 186.35                  |                 |                      |            |
| Variance             | 28,469.81               |                 | 34,727.35               |                 |                      |            |
| Compound growth rate |                         | -92.71          |                         | -80.84          |                      | 53.23      |

#### Trends in national production, yield and area, export, import and price parity.

Figure 1 depicted production trend-line. The production trend-line of potato over 16-year period revealed a steady increase from 2007 to 2023 with 92,000 metric tons to 132,000 metric tons, respectively. The increase in percentage term was 44%,

which is classified as acceleration. Production line showed six peaks and four troughs. Major troughs were noticed in 2009, 2015 and 2020 translating into low potato production in the country. From 2017 to 2019, the production was constant with little fluctuations in between these years, which is classified as stagnation. However, long sharp increase in the production was observed from 2009 and 2014, while a gradual increase occurred in 2021, thus another acceleration. The peak production of potatoes was 130,000 metric tons reached in 2014. Regression equation of trend-line was calculated as  $y=2.2931x+96.815$  with coefficient of determination being  $r^2=0.6052$ .

Similarly, Saxena and Mathur (2013) observed an increase of 32.7% from 270.6 million tons to 357.1 million tons from 1961 to 2020 in India, which was considered an acceleration. Within this time-period, there were trough and peaks noticed. Conversely, Bakhsh et al. (2023) reported a decline in potato production from 2011 to 2020 with very erratic troughs and peaks.

Yield of potato in a hectare as depicted in Figure 1 showed trend-line and productivity in a year. The yield trend of potatoes maintained consistency of 17,000 metric tons from 2007 to 2023 with slight fluctuation, herein referred as stagnation. The regression equation of trend-line was computed as  $y=0.1068x+16.205$  with coefficient of determination of  $r^2=0.6924$ . Similarly, production curve revealed consistency over 16-year time-period from 2007 to 2022, thus a flat line with close to 0 fluctuations. Once again, stagnation was experienced. Kana et al. (2012) found their finding being similar to the above in Nepal having not either increased nor decreased, flat. Conversely, the study conducted in South Africa expressed an increase in the yield by 25 – 35% over a period of 16 years due to the adoption of newly released potato cultivars (Haverkort, et al., 2013).

Trend-line of area under which potatoes were grown expressed consistency of 6,810 hectares over a time-period of 16 years from 2007 to 2023. This revealed infinitesimal change in area planted, classified as stagnancy. Similarly, a curve of area where potatoes were planted over the years also revealed consistency, thus no change occurs in the area grown. The regression equation was work-out as  $y=0.1078x+5.89$  with a coefficient of determination of  $r^2=0.6596$ . Conversely, the trend under which potato exhibited a sharp increase during study period from 1999/2000 to 2017/2018 by 144.62% (Rijah et al., 2023).

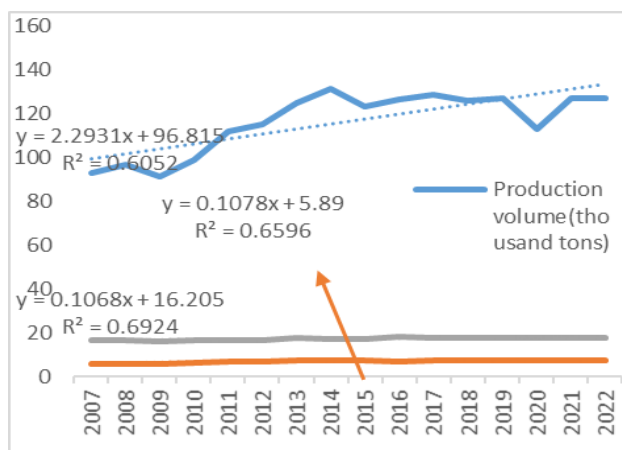


Fig.1: Trends in production, yield and area

#### Trends in national production, export and import value.

Trend-line value of potato over 16-year period revealed an undulating dramatic decline from 2007 to 2023 from US\$64,400 down to US\$31,700, respectively (Fig. 2). This decrease of 50.3% is said to be deceleration. There were four troughs and three peaks around the trend-line. Peaks were observed in year 2011; 2014; 2016 and 2018 with values of US\$70,600; US\$66,700; US\$ 56,600 and US\$50,000, respectively. Similarly, troughs were noticed in year 2009; 2012 and 2020 with values of US\$59,600; US\$56,600 and US\$29,900, respectively (Fig.2). Regression equation of trend-line was calculated as  $y = -2.351x + 73.28$  with coefficient of determination being  $r^2 = 0.734$  (Fig.2).

Trend-line for export value is depicted in Figure 2 below. It expressed a trend-line for export value with neither an increase nor a decrease during 16-year time-period suggesting a stagnation. Regression analysis of export value had an equation of  $y = 0.1607x + 0.69$  with a coefficient of determination being  $r^2 = 0.4362$ . Export curve revealed consistency over 16-year time-period from 2007 to 2022, thus a flat line with close to 0 fluctuations overlaying trend-line. Nonetheless, global export value of potato increased sharply by 309% from US\$ 0.65 billion to US\$5.2 billion in 2000 to 2020, respectively. Similarly, export value of potatoes in Africa rose by 681% to US\$403.2% million from 2000 to 2022. Another rise of 988% to US\$48.1 million potato export value was observed in South Africa during the aforementioned period. This expressed acceleration of potato export value in South Africa, Africa and Globally (Department of Agriculture, Land Reform and Rural Development, 2023).

Import value of potatoes over 16-year period is presented in a form of trend-line below (Fig. 2). Within this time-period, there was neither an increase nor decrease in the import value translating to stagnation. The regression equation of import value was computed as  $y = 0.0233x + 1.075$  with coefficient of determination of  $r^2 = 0.0252$ . Similarly, import value curve revealed consistency over 16-year time-period from 2007 to 2022, thus a flat line with close to 0 fluctuations overlaying trend-line (Fig.2). The import value of potatoes increased over a period of 22 years by 287% to US\$5.7 billion and by 229%

to US\$479 globally and Africa, respectively. That was considered acceleration. Conversely, South Africa experienced a decline in import value by 12% to US\$ 16,000, thus a deceleration (Lungelo, 2024).

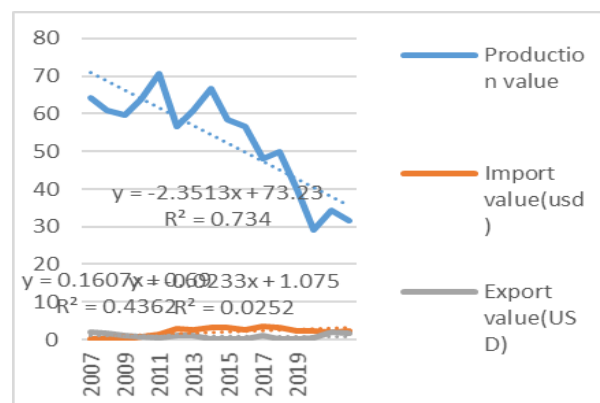


Fig.2: Trends in production, import and export

#### Trend in import and export volumes

Import volume increased exponentially from 2007 to 2022 with three peaks and two troughs. Peaks were observed in 2012, 2015 and 2018 with volumes of 5,300; 11,800, and 10,700 mt. Similarly, troughs were noticed 2013, 2016 and 2020 having volumes of 5.2, 9.1 and 6.3 mt. The increase in import trend is classified as acceleration. The regression analysis expressed the following formula;  $y = 0.6578x + 0.4525$  and coefficient of determination as  $r^2 = 0.6403$  (Fig.3). In South Africa, there was a large increase in the import volume of potato from Southern African Development Community, namely; Namibia, Eswatini, Lesotho and Mozambique. In Europe, potatoes were imported from France, Germany, Belgium and Netherlands. This import volume accounted 45% of the national production of potato, though the figure fluctuated from one year to the other (Potato South Africa, 2023).

Trend-line for export volume revealed a steadfast decline during the period understudy, although the erratic behavior was observed among 16 years. This is classified as deceleration. Four troughs and three peaks were observed around the trend-line. Four peaks were noticed in 2013, 2017 and 2020 with export volumes of 2,500mt, 2,500 mt and 1.8mt, respectively. While troughs were seen in 2011, 2014, 2018 and 2022 with 0.6mt, 0.3mt, 0.25 mt and 0.2mt, respectively. The regression analysis expressed the following formula;  $y = 0.1192x + 0.28076$  and coefficient of determination as  $r^2 = 0.3198$  (Fig.3). Globally, there was a dramatic increase of 110% in export volume from 8.1 million tons to 17.3 million tons during a time-period of 2000 to 2022 characterized by peaks and troughs in between. The fastest growing countries in potato exporters are Pakistan (92.1%), Egypt (57.8%), Canada (46%), and India (34%). Recently, Israel (-8.99), South Africa (6%), Denmark and (0.3%) experienced a dramatic decline during 2000 and 2022. South Africa exhibited an increase of 70.28% from 7.1 million tons to 12.09 million tons in 2000 to 2022, respectively. This translated into an acceleration of growth in export volume

(National Agricultural Marketing Council Annual Report, 2017).

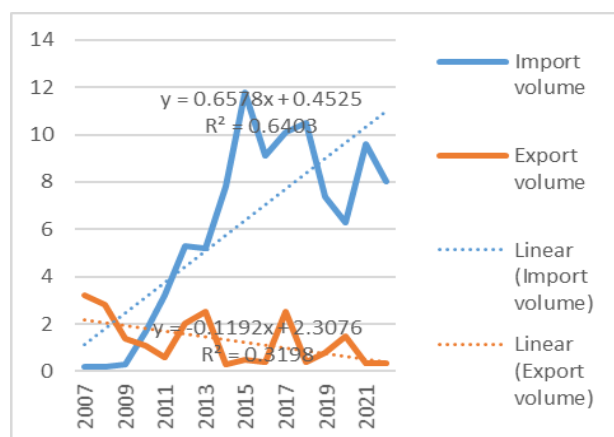


Fig.3: Trends in import and export volume

#### Trend in import and export prices

The prices of both import and export prices decline dramatically from 2007 to 2022 with fluctuations around trend-line. This is referred to as deceleration. Import prices were highly volatile with three peaks and three troughs. The peaks for import prices were noticed in 2009, 2002 and 2021, while troughs were observed in 2008, 20011 and 2015 (Fig.3). The regression equation was  $y = -27.934x + 715.88$  with coefficient of determination of  $r^2 = 0.8961$ . The peaks for export prices were exhibited in 2011, 2014, 2018 and 2021. The regression analysis revealed an equation of  $y = -27.934x + 715.88$  and coefficient of determination of  $r^2 = 0.7404$  (Fig.3).

Globally, import prices increased at a steadfast rate by 86% to US\$ 349/ton from 2000 to 2022 generally higher than export prices. In Africa, potato price increased by 53% to US\$478/ton, while in South Africa rose by 209% to US\$489/ton. This is an acceleration occurring at different rates with fluctuations between (Potato, South Africa, 2017). Similarly, export prices increased at a doubling rate (100%) to US\$4333 per ton world-wide, while export price increased by one half (50%) in Africa and 209% to 489/ton in South Africa (National Agricultural Marketing Council, 2017).

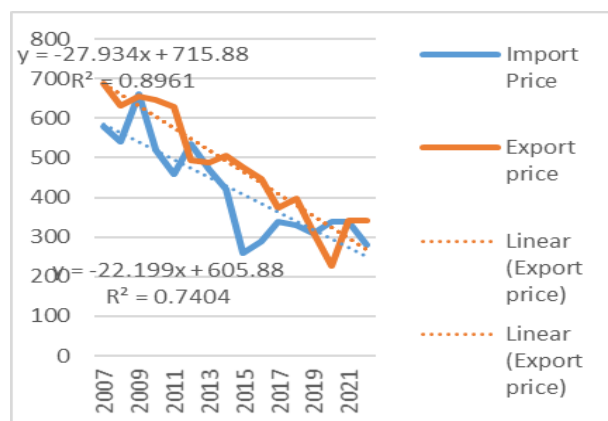


Fig.4 Import and export prices

## CONCLUSION AND RECOMMENDATIONS

Potato industry is at an infant stage as evidenced by low production, productivity and area under which it grown. It necessitates boosting of productivity by applying advanced technologies which includes agronomic practices and adoption of high yielding and disease-free varieties. Extension service needs to be strengthened to assist potato farmers reach a yield plateau. It is observed that in other countries, productivity is far higher than that of Lesotho particularly South Africa which is a neighbor sharing the same environmental conditions. Import volume is far less than export volume which can be increased by high productivity. Potato industry is operating in the negative territory (deficit).

## ACKNOWLEDGEMENT

The authors would like to sincerely thank both Department of Crop Science and Department of Agricultural Economics in the National University of Lesotho for providing all resources required to conduct this study such as funds, transport, personnel and time. Bureau of Statistics, Konoema and Inbox are also acknowledged for providing data used in compiling this manuscript. Assistance from all other people who are not included is highly appreciated.

## CONFLICT OF INTEREST

There is no conflict of interest in the compilation of research proposal, execution and interpretation of the findings of research thereof.

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