

Trend Analysis in Fertilizer Consumption by Field Crops and its Determinants in Lesotho

Motlatsi Eric Morojele^{1*}; Motanyane Stanislaus Motake²

National University of Lesotho, Faculty of Agriculture, Department of Crop Science

*Corresponding Author

Received:- 04 September 2026/ Revised:- 17 September 2026/ Accepted:- 29 September 2026/ Published: 05-10-2026

Copyright @ 2026 International Journal of Environmental and Agriculture Research

This is an Open-Access article distributed under the terms of the Creative Commons Attribution

Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted

Non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract— Inorganic fertilizer was introduced to farmers in the past century by the government to replenish nutrients absorbed by crops grown in the fields. The fertilizer consumption rate has not yet been determined since then. The study was therefore undertaken to: (i) establish the growth rate at which inorganic fertilizer is applied by farmers, (ii) determine the trend in the consumption of inorganic fertilizer by farmers, (iii) disaggregate different types of fertilizer nutrients applied in the country in general and in particular by districts, and (iv) determine factors influencing fertilizer consumption. The study used time-series data obtained from FAOSTAT Fertilizer by Nutrient and AfricaFertilizers IFDC. Data on total fertilizer nutrients and their composition covered the period from 1994 to 2024, while data on consumption covered the period from 2014 to 2025. Microsoft Excel was used to capture data, after which it was analyzed using the Statistical Package for Social Sciences (SPSS) to calculate mean, variance, standard deviation, annual and compounded growth rates, trendlines, linear regression analysis, and instability index. Results revealed that the mean fertilizer consumption over 30 years was 5,700 tons, with minimum and maximum consumption rates of 3,500 tons and 7,800 tons, respectively. The growth rate in consumption increased steadily, with a mean growth rate of 9.3%. The compounded annual growth rate was 64.5%, with the highest and lowest rates of consumption being 17.1% and 4.4%, respectively. The mean nitrogen consumption was 3,892 tons, with a minimum consumption of 3,310 tons and a maximum of 4,350 tons. Phosphorus consumption recorded a mean of 1,431 tons, with a maximum of 1,580 tons and a minimum of 1,190 tons. The mean potassium consumption was 1,036 tons, with the lowest consumption of 850 tons and the highest consumption of 1,301 tons, respectively. The trend in nitrogen, phosphorus, and potassium consumption expressed modest growth over the period under study. Nitrogen was trending at a higher level than the latter two, which were at slightly different levels. Large quantities of fertilizer were distributed to Berea, followed by Maseru district, while the districts with the lowest quantities were Mokhotlong and Qacha's Nek districts, respectively. Consumption of fertilizer is influenced by fragmented fields, prohibitive costs, ineffective input subsidy policy, lack of institutional support, and inaccessibility by highlands farmers. It is recommended that fertilizer programmes be established by the government, funded by donors and development agencies, in the Southern and highlands regions where the application rate is too low due to inaccessibility and unaffordability.

Keywords— Fertilizer consumption, trend analysis, nitrogen, potassium, phosphorus, Lesotho.

I. INTRODUCTION

Crops require nutrients in varying amounts to grow, develop, flower, and give a substantial yield, some of which are already available in the soil in excess, while others are in short supply [1], [2]. Among these nutrients, there are those that are said to be essential; thus, the plants cannot complete their life cycle without them [3]. These are nitrogen, phosphorus, potassium, sulphur, magnesium, and calcium [4], [5]. Based on the large amounts required by plants, these are called macronutrients, while those needed in small or minute quantities are micronutrients [6]. Besides the two aforementioned categories of nutrients, there are some required in large quantities but readily available in the atmosphere, with no need to apply them to the crops since they are in abundance and are easily captured by plants, namely carbon, hydrogen, and oxygen [7]. Where field crops are grown over a longer period of time, the two categories get depleted in particular macronutrients, necessitating replenishment

based on the requirement of the crop to be grown, while vegetables need both categories in substantial amounts, otherwise they express deficiency symptoms of the nutrient that is inadequate in plants [8], [9]. The deficiency symptoms for each nutrient are distinct and can be established by visual assessment, soil sampling to determine nutrient status, or plant/tissue analysis to quantify and identify elements below threshold [5], [10].

To replenish nutrients depleted below the crop requirement, supplementary nutrients must be applied in the form of fertilizer differing in formulations such as granular, powder, spray, liquid, capsules, slow release, pellets, fumigants, and effervescent and non-effervescent tablets [4], [11], [12]. The former four are mostly applied in field crops, while the latter six are adopted in vegetable crop production. Nutrients are applied in two splits: basal dressing just before, during, or immediately after planting the seeds of the crop. The other split is top-dressing, applied to growing crops, in particular nitrogenous fertilizers, because they are subject to great losses through volatilization, leaching, and immobilization [4]. Phosphorus and potassium are applied at planting in one dose without splitting them. The correct amount, right time of application or stage of the crop, and placement of the fertilizer in proximity to plants are of paramount importance, enabling crops to beneficially utilize the fertilizer for optimal growth and yield [13].

In Lesotho, field crop production began in time immemorial to feed its nation and sell surplus to other nations in their neighborhoods to get cash for other household requirements. With time, soil nutrients got depleted and had to be replenished by organic manure derived from farm animals reared. Nonetheless, benefits derived from organic manure were slow to enrich the soil with nutrients and produce optimal yield; thus, their effects were not immediate but cumulative over time. Nutrients in the manure were released slowly in small amounts, inadequate to meet the crop requirement. With the advent of colonization by the British Government, fertilizer was introduced to supersede organic manure, though there was resistance by the farmers to adopt it in their cropping systems. Nonetheless, it gained more popularity through extension service deployed in the communities to conduct methods and result demonstrations with farmers. It then became available in retail shops and through donations from donor partners and development agents. The adoption rate of fertilizer use spread countrywide across all different types of field crop farmers. To date, no scientific study has been conducted to determine the dynamics of fertilizer use since its introduction. It is therefore for this reason that the study is generally undertaken to track the consumption rate of fertilizer by farmers over time. While the specific objectives are to: (i) establish the growth rate at which inorganic fertilizer is applied by field crop farmers, (ii) determine the trend in the consumption of inorganic fertilizer by field crop farmers in Lesotho, (iii) disaggregate different types of nutrients in the fertilizer applied in the country in general and in particular by districts, and (iv) determine socio-economic factors influencing fertilizer consumption.

II. MATERIAL AND METHODS

2.1 Study Area

The study was carried out in Lesotho, which is situated in Southern Africa and covers a surface area of 33,355 km², of which about 365,748 ha is devoted to arable land utilized by 227,983 individual farmers and 199,059 agricultural households. The country is divided into four agro-ecological zones, namely lowlands, foothills, mountains, and Orange River valley, and again divided into ten districts: Maseru, Mafeteng, Mophale's Hoek, Quthing, Qacha's Nek, Mokhotlong, Botha-Bothe, Leribe, Berea, and Thaba-Tseka. The coordinates of Lesotho are approximately 29.61° S and 28.23° E. The altitude ranges between 1,100 m and 3,500 m above sea level. It has a population of 2.2 million [14]. It is agriculturally oriented, with 70% of the population depending on it for their livelihoods. It is mostly practiced in rural areas, where old traditional methods are still adopted by subsistence farmers, and a very small number (560) of emerging commercial farmers have embarked on modern farming practices [15].

2.2 Climate

Lesotho has a temperate climate characterized by warm summers, with temperatures ranging between 22°C and 33°C and few incidences of rising to 37°C. The winter season is very cold, with freezing temperatures dropping to -7°C, accompanied by shallow and deep snowfall in the lowlands and highlands, respectively. The average annual rainfall is approximately 750 mm, with a maximum of 1,200 mm and a minimum of 400 mm. Rainfall commences in October and increases gradually until it reaches a peak in February, after which it decreases faster and stops in April. May, June, and July are dry seasons [16].

2.3 Data Collection

The study used time-series data obtained from both FAOSTAT Fertilizer by Nutrients and AfricaFertilizers IFDC.org: Lesotho country dashboard, which were consistent. Lesotho does not produce its own fertilizer and therefore imports it from South

Africa. The data on fertilizer covered a time period of thirty (30) years, spanning from 1994 to 2024, on total nutrients and their differing composition. Data on consumption and importation spanning over a period of fifteen (15) years from 2014 to 2025 were obtained from the aforementioned sources.

2.4 Data Analysis

Time-series data collected on fertilizer consumption and maize production were captured and stored in an Excel spreadsheet (version 25), after which the data spanning over a period of thirty (30) years were blocked into five (5) year time periods (TP), each block having an average data of five (5) years, thus 1994–1998 (TP1), 1999–2003 (TP2), 2004–2008 (TP3), 2009–2013 (TP4), 2014–2018 (TP5), 2019–2023 (TP6), and 2024–2026 (TP7). The time period of five (5) years is aligned with five (5) year National Strategic Development Plans (NSDP), which review the strategies, policies, and interventions to address agricultural challenges, after which impact is assessed. The Statistical Package for Social Sciences (SPSS) was employed to draw the linear graph for production and area grown. Growth rate was compared among the time periods to determine deceleration, stagnancy, or acceleration in fertilizer consumption and maize production. The instability index was calculated for production, consumption, and importation using a formula by Karim and Ismail (2007):

Formulas applied in the study:

(a) Mean = Summation of observations / number of observations (15 years)

$$\bar{X} = (\Sigma X) / N \quad (1)$$

where:

- Σ = Total of observations
- N = Number of years
- X = Observations

(b) Standard Deviation

$$s = \sqrt{[\Sigma(x - \bar{x})^2 / (n - 1)]} \quad (2)$$

where:

- X = Observations
- $\bar{x}$ = Mean of the observations
- n = Number of years

(c) Variance

$$\sigma^2 = \Sigma(x - \mu)^2 / N \quad (3)$$

where:

- Σ = Total of observations
- X = Observations
- N = Number of years
- μ = Observation mean

(d) Coefficient of Variation

$$CV (\%) = (\text{Standard deviation} / \text{Mean}) \times 100 \quad (4)$$

Standard deviation derived from (b) above.

(e) Compound Annual Growth Rate

$$CAGR = [(V_f / V_i)^{(1/n)} - 1] \times 100 \quad (5)$$

where:

- V_f = Final value
- V_i = Initial value
- n = Number of years

(f) Annual Growth Rate

$$AGR = [(Value\ in\ t\text{-}th\ year - Value\ in\ (t-1)\text{-}th\ year) / Value\ in\ (t-1)\text{-}th\ year] \times 100 \quad (6)$$

(g) Linear Regression

$$r = [n(\sum xy) - (\sum x)(\sum y)] / \sqrt{\{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]\}} \quad (7)$$

where:

- N = All observations
- Σ = Summation notation
- x = Observation of one variable
- y = Observation of the other variable

$$I = CV \times \sqrt{(1 - R^2)} \quad (8)$$

where:

- I = Instability index
- CV = Coefficient of variation
- R^2 = Coefficient of determination

Using the same data spanning over thirty (30) years, linear graphs and trend lines were drawn to determine the long-term performance of fertilizer consumption. Both the linear regression and coefficient of determination were calculated.

III. RESULTS AND DISCUSSION

3.1 Growth Rate of Fertilizer Consumption

The mean fertilizer consumption over 30 years was 5,700 tons, with a minimum consumption rate of 3,500 tons, which occurred in 1994–1998 (TP1), while the maximum consumption rate was 7,800 tons, exhibited in time period 2024–2026. The growth rate in the consumption of fertilizer increased at an increasing rate from the first time period (TP1) to the second time period (TP2), and from the second time period to the third time period (TP3), after which the growth rate started to increase at a decreasing rate. The mean growth rate over thirty years was 9.3%. There was no negative growth rate experienced among the seven time periods under study.

The compounded annual growth rate in fertilizer consumption for 30 years from 1994 to 2024 was 64.5%. The highest rate of fertilizer consumption was 17.1%, observed during time period 3 from 2004–2008, while the lowest rate of 4.4% was revealed in time period 7 from 2024–2026. The broad range of fertilizer consumption was experienced in four time periods, namely TP4, TP5, TP6, and TP7, while a narrow range of fertilizer consumption was shown in TP1 and TP3. TP2 featured in the middle of the two aforementioned. In Lesotho, fluctuation in both annual and compounded growth of fertilizer consumption is attributed to inflation, which increased the cost of fertilizer, thereby reducing the amount to be purchased; government budgetary constraints pressuring allocation of funds for fertilizer to be lowered; and fluctuating foreign exchange rates since fertilizer is not produced domestically but imported from international markets. Among the neighboring Southern African Development Community (SADC) members of which Lesotho is part, different growth rates are observed. Eswatini revealed a similar annual and compound fertilizer growth rate to that of Lesotho, increasing gradually due to the sugar cane, pineapple, and orange industries, and limited fertilizer demand from individual farmers [17]. Few agricultural programs demand insignificant quantities of fertilizer, with minimum increase to the total country consumption. In Botswana, the annual and compounded fertilizer growth rate has been increasing because of the commercialization of farms, government programs on fertilizer, and a very low base [18]. Malawi has been experiencing a highly volatile trend of annual and compound growth rate caused by government subsidy programs and fertilizer price shocks [18].

TABLE 1
TOTAL FERTILIZER CONSUMPTION IN TIME PERIODS

Year	Time-period (TP)	Lower and Upper Limit of Fertilizer Consumed (tons)	Difference in Fertilizer Consumption (tons) within Time-periods	Mean Fertilizer Consumed (tons)	Annual Growth Rate (%)	Compound Annual Growth Rate (%)
1994–1998	1	3,500–4,200	700	3,850	—	—
1999–2003	2	4,000–4,800	800	4,400	14.3	14.3
2004–2008	3	4,800–5,500	700	5,150	17.1	31.4
2009–2013	4	5,500–6,500	1,000	6,000	16.5	47.9
2014–2018	5	6,000–7,000	1,000	6,500	7.7	55.6
2019–2023	6	6,500–7,500	1,000	6,850	5.4	61
2024–2026	7	6,800–7,800	1,000	7,150	4.4	65.4
Mean			885.7	5,440.90	9.3	
Standard deviation			135.5	1,169.25		
Variance			21,428.60	13,67,145.50		
Coefficient of variation			15.3	21.49		
Stability Index				12.8		

3.2 Trend in Total N + P + K, and Nitrogen, Phosphorus, and Potassium Individually

3.2.1 Nitrogen, Phosphorus, and Potassium Consumption

The trend lines of nitrogen, phosphorus, and potassium consumption individually and in combination over thirty years are depicted in Figure 1 below. The trend line for the total combination of nitrogen, phosphorus, and potassium revealed a modest increase on average in consumption, with slight dips and peaks, which may be referred to as an acceleration rather than deceleration or stagnation. The regression analysis of the total combination of the three aforementioned nutrients had an equation of $y = 126.89x + 5537.7$, with the coefficient of determination being $R^2 = 0.6436$. Similarly, the nitrogen trend line showed a steady increase with peaks and dips in consumption over a stipulated period of 11 years, which is also called acceleration. The regression analysis of nitrogen consumption expressed an equation of $y = 482.77x$, with the coefficient of determination being $R^2 = 0.8283$. The trend line for phosphorus consumption exhibited an almost consistent flat line, which may be referred to as stagnant. Its regression line is $y = 23.112x + 1283.9$, with the coefficient of determination being $R^2 = 0.4795$. Likewise, potassium consumption revealed a consistently flat line across the time period. The regression analysis presented a formula of $y = 31.815x + 829.12$, with the coefficient of determination being $R^2 = 0.6682$. Potassium and phosphorus are comparable in terms of trend lines.

In Tanzania, the trend line for nitrogen, phosphorus, and potassium follows a U-shaped curve, being applied at a high rate and suddenly going down from 1966 until 1990, after which it went up again [19], [20]. This was due to government subsidy being introduced suddenly in large amounts and stopped, then increased again in large amounts. Besides, there were imports driving recovery [19]. In Zimbabwe, the fertilizer consumption trend, including nitrogen, phosphorus, and potassium, has declined tremendously after gaining independence from colonial rule due to its exorbitant cost, which 91% of farmers could not afford; escalating interest rates charged by banks for purchasing fertilizer; lack of knowledge on its utilization by indigenous farmers owning land; electricity power cut-off; and high foreign exchange rates since it is importing raw materials for manufacturing fertilizer from outside the country [21], [22]. According to World Bank data for Zimbabwe, fertilizer consumption dropped by 43% from 2003 to 2015 [23]. Conversely, consumption of fertilizer in Kenya has been increasing annually by 19% from 2010 to 2024 [22]. Nitrogen was the most popular nutrient, although its application was inefficient, resulting in a loss of 50% due to leaching, volatilization, and immobilization. Besides, soil acidity posed a serious problem, making it unavailable to plants. Application of potassium has been ignored historically, leading to low levels in the soil [23].

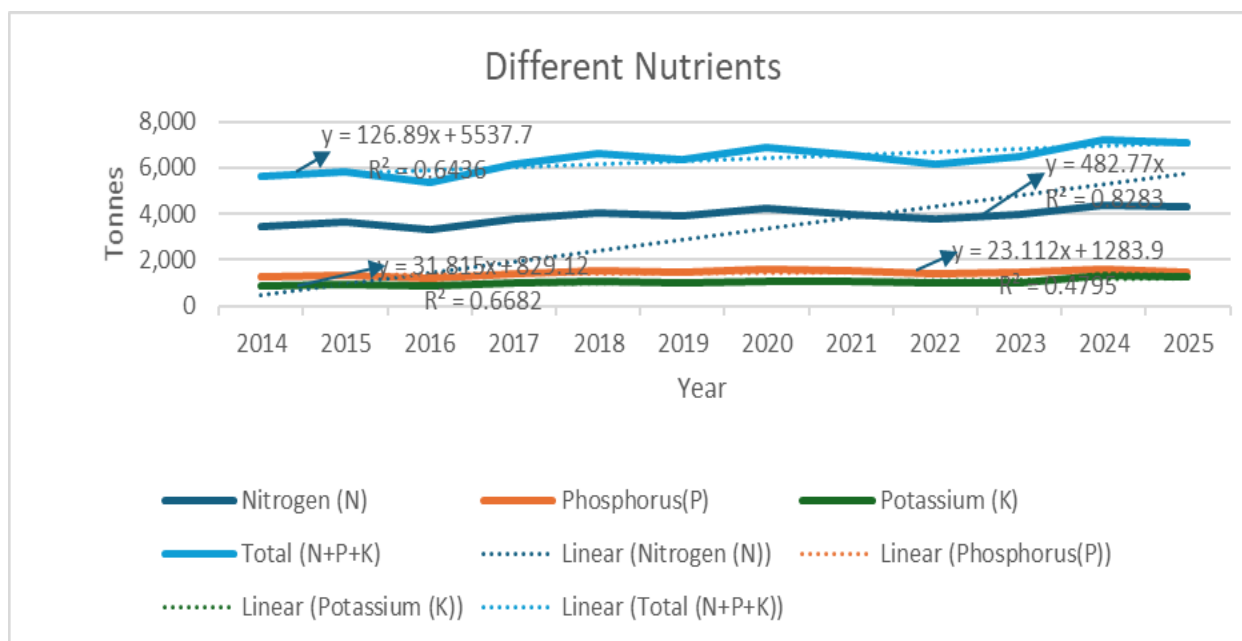


FIGURE 1: Trend in total N+P+K, and nitrogen, phosphorus, and potassium individually

3.3 Disaggregation of Different Nutrients in the Fertilizer Applied

The mean nitrogen consumption over the period of twelve (12) years was 3,892 tons, with the minimum consumption of 3,310 tons observed in the year 2016, while the maximum of 4,350 tons was experienced in the year 2024. The consumption of nitrogen was very erratic over the 12-year period. Nitrogen consumption was dominating, with an amount three (3×) times higher than other nutrients, namely phosphorus and potassium (Table 2). This is due to the fertilizer mix in a bag already containing a higher percentage of nitrogen content than other nutrients. Nitrogen was applied in two doses: as basal dressing during planting time and again on standing crop (top-dressing) before flowering or tasseling (six weeks after planting) of the crop, since it is subject to losses such as mobilization, volatilization, and leaching. The consumption of nitrogen is high because the farmers have realized that it contributes significantly toward crop growth, development, and yield. Comparatively, nitrogen consumption in Kenya and Zimbabwe are at par, with 133,300 and 139,500 tons, respectively [19]. The application rate is high because there are commercial farms and plantations which consume large amounts of fertilizer, thus nitrogen. Lesotho's nitrogen consumption is very low because it is only the government that supports the farmers with nitrogenous fertilizer, and little, if any, programs funded by United Nations Agencies sometimes intervene. Their impact is insignificant. This necessitates a campaign for more programs with intensive fertilizer application to the crops in Lesotho, of course after determining soil fertility.

Phosphorus followed nitrogen in consumption by a mean of 1,431 tons and a maximum of 1,580 tons and a minimum of 1,190 tons. The amount of phosphorus applied above the mean occurred in six years, while the amount below the mean also took place in six years. Below and above the mean, applied phosphorus was fluctuating (Table 2). There has been an increase in the consumption of phosphorus in the first three years from 2014 to 2016, after which it levelled off until 2025. It is considered to be the second nutrient to nitrogen in demand, and its importance is less to farmers. Conversely, there is a large difference between phosphorus consumption in Kenya and Zimbabwe, with 116,400 and 186,000 tons, respectively. This difference is attributed to the amount of these nutrients already in the soil of each country and the crops that are grown [22].

The mean potassium consumption over 12 years from 2014 to 2025 was 1,036 tons, with the lowest consumption of 850 tons and the highest consumption of 1,301 tons. The trend in potassium consumption was fluctuating, showing an increase initially for the first five years, followed by a constant consumption of four years, after which it escalated in the last two years. Potassium consumption below the mean occurred in seven years, while above the mean was expressed in five years. The peak periods were from 2018 to 2021 and 2023 to 2023, respectively. In 2022, there was a trough similar to the beginning in 2017. Potassium in Kenya is far higher than Zimbabwe, recording 42,800 and 4,000 tons, respectively. High amounts of potassium in Kenya are ascribed to frequent wildfires and tree burning, producing ash that contains potassium. Besides, the farmers burn trash and leftovers after harvesting, thereby adding potassium.

The mean for the total amount of all nutrients (N, P, and K) applied from 2014 to 2025 was 6,363 tons, revealing a minimum of 5,350 tons in 2016 and a maximum of 7,230 tons in 2024 (Table 2). In general, there was a steady increase in consumption over the study period, even though there were slight dips and peaks in some years. The three aforementioned nutrients were combined in particular proportions and bagged in 50 kg pockets. Nitrogen, phosphorus, and potassium constituted a proportion of 3.8%, 1.5%, and 1%, respectively. Nitrogen was in high amounts because most crops need it in large quantities and it is limited in the soils of Lesotho, necessitating supplementary application. Phosphorus follows nitrogen in amounts required by crops and is inadequate to meet the requirements of most crops, though in less quantities than nitrogen. Similarly, potassium is another nutrient needed by crops in less amounts than both nitrogen and phosphorus. Relatively, Lesotho soils have a lot of potassium, which is getting depleted gradually because it has not been replenished in the past, necessitating supplementation in minute amounts. The three above-mentioned nutrients are essential for growth, development, and yield formation, and their inadequacy may affect the latter.

TABLE 2
DIFFERENT FERTILIZER NUTRIENTS APPLIED COUNTRY-WIDE BY YEAR

Year	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Total (N+P+K)
2014	3,450	1,280	890	5,620
2015	3,620	1,310	920	5,850
2016	3,310	1,190	850	5,350
2017	3,780	1,420	980	6,180
2018	4,050	1,530	1,050	6,630
2019	3,890	1,460	1,010	6,360
2020	4,220	1,580	1,100	6,900
2021	4,010	1,500	1,040	6,550
2022	3,760	1,400	970	6,130
2023	3,980	1,480	1,030	6,490
2024	4,350	1,570	1,301	7,230
2025	4,280	1,490	1,290	7,060
Mean	3,892	1,431	1,036	6,363
Variance	23,42,736	14,481.06	19,692.80	3,25,220.50
Standard deviation	1,530.59	120.33	134.4	546
Coefficient of variation	39.3	84.1	12.97	8.58

Source: Food and Agriculture Organization of the United Nations. 2025. Land, Inputs and Sustainability: Fertilizer Nutrients.

3.4 Disaggregation of Total Fertilizer and Nutrients by Ten Districts

The distribution of fertilizer to the ten districts of Lesotho was inequitable based on arable land expected to be grown each year, types of crops, potential of the area, and seasonal weather forecast (rainfall). The data provided below in Table 3 is a mean of twelve years, showing districts supplied, total fertilizer distributed in each district, and different nutrients.

Berea ranks the first highest among the districts supplied with fertilizer, amounting to 4,287.7 tons, constituting 24% of the total distribution to all districts. Because of the large quantity of fertilizer allocated to Berea district, the fertilizer nutrients applied are higher than in other districts. Maseru district followed with 3,922.3 tons, constituting 12.9% of total fertilizer distribution, while nutrients applied were 640 tons of nitrogen, 238 tons of phosphorus, and 165 tons of potassium. Conversely, Mokhotlong district was supplied with the lowest amount of fertilizer, to the tune of 298.9 tons, constituting 1.7% of national distribution. Nutrients such as nitrogen, phosphorus, and potassium contained in the fertilizer were 84 tons of nitrogen, 31 tons of phosphorus, and 22 tons of potassium. Mokhotlong was followed by Qacha's Nek with a total fertilizer amount of 432 tons, constituting 1.7% of national distribution. Low amount of fertilizer usage is due to late arrival in the aforementioned districts and its exorbitant cost, since almost all farmers are unemployed. Fertilizer contained 107 tons of nitrogen, 40 tons of phosphorus, and 28 tons of potassium. Disaggregation of total fertilizer and nutrients in the districts is consistent with that of Eswatini regions. Based on the four regions of Eswatini, which in total utilize 14,700 tons, Manzini applies the highest quantity of fertilizer, amounting to 5,145 tons, followed by Lubombo and HHOHHO with both 3,675 tons, and the least is Shiselweni with 2,205 tons. Manzini region uses NPK (2:3:2(22)), urea, and potassium chloride for vegetables and sugar cane production.

Lubombo region applies nitrogen and potassium chloride for sugar cane production as well. Conversely, HHOHHO utilizes blended NPK fertilizer for maize and vegetable production [20], [24]. Shiselweni region, being cultivated by subsistence farmers, incorporates very low amounts of phosphorus and potassium, and almost all nutrients are depleted because of non-replenishment [25].

To improve fertilizer consumption in Lesotho, there is a dire need to establish a fertilizer plant that would sell fertilizer at a lower cost and specific to a particular area, meeting the crop requirement. This initiative has been reiterated on many occasions with many efforts, such as writing project proposals and sourcing funding, but all in vain. The Ministry of Agriculture, Food Security and Nutrition (2022) has detailed information on a fertilizer plant in Lesotho.

TABLE 3
DISTRIBUTION OF FERTILIZER AND NUTRIENTS PER DISTRICT

District	Total Fertilizer	% National	N tonnes/Year	P ₂ O ₅	K ₂ O
Berea	4,287.70	24	705	262	182
Maseru	3,922.30	12.9	640	238	165
Leribe	3,392.10	19	617	229	159
Mafeteng	1,872.80	10.5	575	214	149
Mohale's Hoek	1,234.50	6.9	438	163	113
Thaba-Tseka	1,089.20	6.1	236	88	61
Quthing	987.4	5.5	186	69	48
Botha-Bothe	654.3	3.7	221	82	57
Qacha's Nek	432.1	2.4	107	40	28
Mokhotlong	298.9	1.7	84	31	22
Mean	1,817.13	9.27	380.9	141.6	98.4
Variance	22,39,153.58	54.64	57,396.99	7,930.93	3,812.93
Standard Deviation	1,496.38	7.39	227.28	84.49	58.58
Coefficient of Variation (%)	82.3	79.71	59.67	59.67	59.53

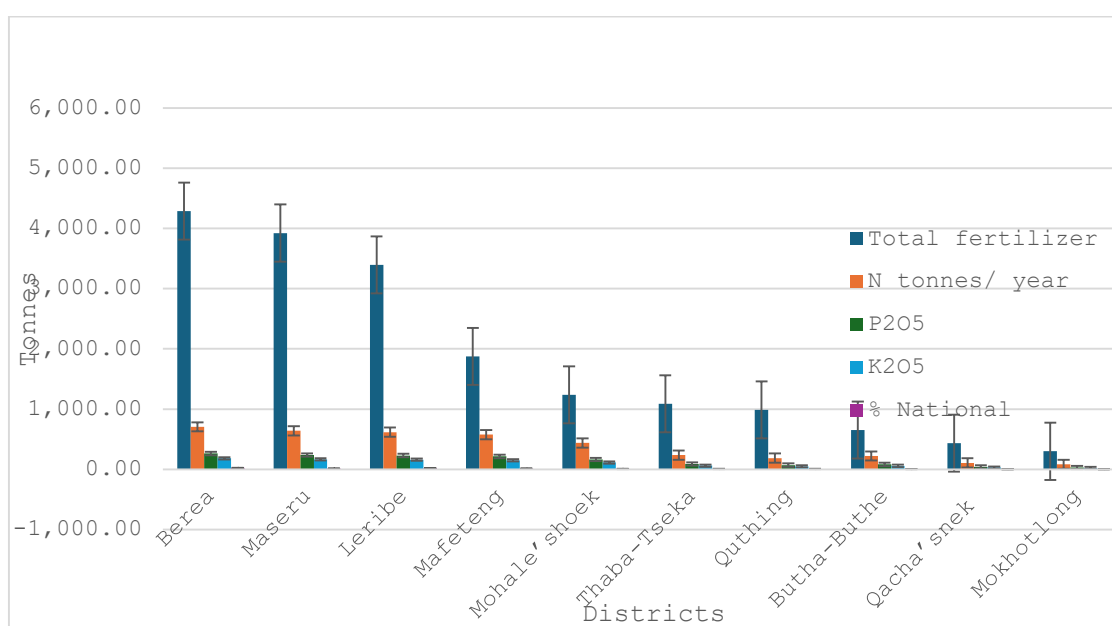


FIGURE 2: Distribution of fertilizer and nutrients per district

3.5 Factors Influencing Fertilizer Consumption

Consumption of fertilizer is influenced by many factors grouped into the following: field size and regions, economic factors, policy and institutional factors, climate, market, and external factors.

3.5.1 Regions and Field Size

Lesotho is divided into three regions, namely Northern lowland, Southern lowland, and Mountain regions (Table 4). The Northern region comprises Leribe, Berea, Botha-Bothe, and Maseru districts. The field size in this region ranges from 1 to 3 hectares, with moderate soil fertility necessitating replenishment annually. This region has the highest fertilizer use among the three aforementioned, with little, if any, organic manure. There are more commercial farmers who have easy access to fertilizer from government subsidy, retail outlets, and South Africa, which is a neighboring country enclaving Lesotho. Farmers are more cognizant of fertilizer use and agronomic practices because of extension officers deployed among them and influence from progressive commercial farmers in the neighboring South Africa. Besides, there is ample rain almost every year, allowing dissolution of fertilizer and its absorption by crops, hence being efficiently used. The government encourages block farming, which uses subsidized fertilizer intensively [26]. Manzini region of Eswatini is experiencing a similar situation to that of the Mountain regions of Lesotho, characterized by high agricultural production due to high fertilizer use, good agricultural soil, high rainfall, and adoption of proper agronomic practices [24].

The Southern Lowlands consists of Mafeteng, Mohale's Hoek, and Quthing districts. The field size ranges from 1–2 hectares (Table 4), with low soil fertility, shallow depth, poor physical and chemical properties, and, above all, very arid conditions, with most of the growing season exposed to drought. The fertilizer use is moderate to low, with a higher application rate of organic manure than in the northern region. Most farmers have limited knowledge of fertilizer use and its significance on crop growth, development, and yield. This region is characterized by high costs of ferrying fertilizer to the destinations, thus farmers in the rural farming households, poor road networks which are mostly dead roads, and fewer extension officers deployed among farming communities. Similarly, block farming is encouraged by the government, which in turn uses fertilizer in higher amounts [25]. Lubombo and HHOHHO regions of Eswatini exhibited a situation equivalent to Southern Lesotho, with moderate lower agricultural productivity as a result of less fertilizer consumption rate and not so much conducive climate conditions [18].

The Mountain region is constituted by Qacha's Nek, Mokhotlong, and Thaba-Tseka districts. The field size ranges from <1.5 hectares (Table 4), with shallow, highly organic, and moderately gravelly soil mostly situated on slopy land. The soil is declared as having low potential for crop production. Fertilizer use is lowest because of limited quantity and late delivery to the farmers, in particular government-subsidized one. The cost of fertilizer that is sold at retail outlets (unsubsidized) is too high and unaffordable by most farmers. A low number of farmers apply insignificant amounts of kraal manure to their fields to replenish nutrients, which does not make a difference; hence crop yield remains lower [25]. Contrarily, the worst-performing mountain region of Lesotho is far much better than that of the Shiselweni region of Eswatini. This is attributed to poor soil conditions, no fertilizer application at all, and crop cultivation conducted by predominantly subsistence farmers lacking proper agronomic practices and acumen [17].

The average fertilizer use was 8.7 kg/ha in 2025, with 45.1% of the planted area fertilized. The government has been offering an agricultural input subsidy of 80%, which was limited by cash, transport, and access in mountains. Recently, fertilizer use has been increased due to commercial vegetable production under tunnels and shade-nets. It would be ideal to have different programs established in each region, tailor-made to optimize crop productivity through judicious use of both inorganic and organic fertilizer, aiming at increasing soil fertility and improving soil conditions.

TABLE 4
SUMMARY OF FERTILIZER USE BY THE REGIONS, FIELD SIZE, ACCESS, AND IMPACT

Region (ton)	Districts	Field Size	Fertilizer Use	Access to Fertilizer	Impact of Fertilizer
Northern (54,870.3)	Leribe, Berea, Botha-Bothe, Maseru	1–3 ha	Highest in the country	Best access	High yield
Southern (12,978)	Mafeteng, Mohale's Hoek	1–2 ha	Medium application	Moderate access	Moderate to Low yield
Mountain (5,324)	Quthing, Qacha's Nek, Mokhotlong, Thaba-Tseka	<1.5 ha	Lowest application	Hardest to access	Low yield

3.5.2 Socio-economic Factors

Socio-economic factors are constituted by gender, age, social, institutional, and policy issues. Table 5 summarizes all the aforementioned. In all regions, men predominated in farming practices, even though a large number of women were observed rallying closer to men in the northern region. The Mountain region comprised the lowest number of female farmers, constituting 23.5% in the region. The large number of farmers actively involved in farming are in the range of 35–54 years, considered to be within middle age approaching old age. This group is characterized by high energy, a wealth of experience, and a fountain of farming knowledge, either in crop production, livestock, or both, depending on the region. The Northern region alone consists of aging farmers losing energy gradually and becoming frail, while the mountain and southern regions are energetic and have a long time remaining in the farming practice. Nonetheless, in all age groups mentioned, the number of youths was infinitesimally small. There was a great variation among the regions in terms of the number of people engaged in farming, as the northern region led by 139,913 and the Southern region ranked the lowest, with the number of farmers recording 38,596. Major drivers behind fertilizer use were ranked as availability of income generated by farmers through crop sales and remittances. Then followed by the existence of agro-dealers in close proximity to farmers, market places to sell surplus produce for cash and purchase other household requirements, and lastly, challenges faced including, among others, land fragmentation, credit inaccessibility and cash availability, costs of inputs and transport, and policies review to stand the test of time, thus subsidies, credit facilities, and programs to assist farmers.

Comparatively, socio-economic factors that affect fertilizer consumption in Botswana are semi-arid climate, livestock dominance, farm size and mechanization, income and poverty, input supply and transport cost, subsidy program, and communal land tenure [27]. In Eswatini, socio-economic factors affecting fertilizer consumption are commercial agriculture in place, agricultural input subsidy, farm size and type, income and credit, education and extension, and infrastructure [24].

TABLE 5
SUMMARY OF SOCIO-ECONOMIC FACTORS AFFECTING FERTILIZER USE

Region	% Female	Age (years)	No. Farmers	Drivers	Challenges
Northern	48.9	55 and over (45%)	1,39,913	Income, Market, Access to agro-dealers, proximity to South Africa, Acquisition of agronomic practices, Credit availability, government-based	Land fragmentation, Age group (<55), Policies, Credit inaccessibility, Cost of living and agricultural inputs
Southern	36.8	35–54 (44%)	38,596	Active labour force (35–54), Income, Availability of agro-dealers, Market for produce, labour largely constituted by women (36.8%)	Drought-prone, mostly below poverty line (60%), Few agro-dealers, high transport cost
Mountain	25.3	35–54 (44.8%)	49,390	Active labour force, Income and mostly men, Agro-dealers, Livestock driving economy	Low income and cash circulation, travel long distance to agro-dealers, priority given more to livestock than crops, Less knowledge acquisition by farmers

IV. CONCLUSION

The fertilizer consumption rate of 8.7 kg ha⁻¹ in Lesotho is relatively low compared to Eswatini with 74 kg ha⁻¹ and Botswana with 15 kg ha⁻¹ as neighboring countries sharing many factors in common and subscribing to membership of regional economic development bodies such as SADC, SACU, etc. [18]. In both countries, agricultural programs in place include intensive use of fertilizer in plantations such as orange, banana, pineapple, and sugar-cane production in Swaziland. These programs are heavily funded by Commonwealth Development Cooperation, Tibiyo Taka Ngwane King's Trust, and many other World Development Partners. The dire situation in Lesotho necessitates nutrient soil mapping and crop suitability mapping synchronization nationwide. Since maize, beans, wheat, potatoes, and sorghum are predominant, they could be used as crop models for determining optimum nutrient requirements that would give substantial yield, and fertilizer application rates that would build up soil fertility status to the level of just replenishing annually nutrients removed by the previous crop. Other ameliorates for increasing efficient utilization of crop nutrients should be applied, such as heavy organic manure to improve soil properties, water-holding

capacity, resistance to soil erodibility, and infiltration rate. Besides, judicious crop planning incorporating beneficial crop rotation based on commonly grown crops, mulching using both organic and inorganic materials, leguminous cover crops, and green manure should be adopted for the long-term benefit of both soil and crops. All these would recuperate the soil fertility conditions of the Lesotho arable land.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

- [1] Khatun, A., Mukherjee, S., Bullah, M. M., & Bhattacharya, P. (2024). Effects of micronutrients on crop quality. *International Journal of Research in Agronomy*, *7*(4), 107-114. <https://doi.org/10.33545/2618060X.2024.v7.i4b.537>
- [2] Dhobhal, A. (2023). Advances in plant nutrition: A comprehensive review. *International Research Journal of Agricultural Science and Soil Science*, *12*(4), 1-3.
- [3] Solberg, M. (2025). Plant nutrition: Essential elements, uptake mechanisms, and physiological significance. *International Research Journal of Plant Science*, *16*(28), 1-2.
- [4] Cao, W., et al. (2025). Progress in the study of plant nitrogen and potassium nutrition and their interaction mechanisms. *Horticulturae*, *11*(8), 930. <https://doi.org/10.3390/horticulturae11080930>
- [5] Salam, N. K., et al. (2025). Optimizing soil nutrient dynamics: Recent insights into soil-plant interactions. *International Journal of Research in Agronomy*, *8*(5), 846-854. <https://doi.org/10.33545/2618060X.2025.v8.i5g.2994>
- [6] Alemayehu, K. (2023). The role of essential nutrients in enhancing plant growth and secondary metabolite synthesis. *International Journal of Bioscience and Biochemistry*, *5*(2), 40-43. <https://doi.org/10.33545/26646536.2023.v5.i2a.80>
- [7] Aye, H. N., & Masih, S. (2023). Role of nutrients in plants, its deficiency and management. *International Journal of Plant & Soil Science*, *35*(10), 129-136. <https://doi.org/10.9734/ijpss/2023/v35i102932>
- [8] Lyu, J. (2026). A nitrogen-response coordinator. *Nature Plants*, *12*(3), 483. <https://doi.org/10.1038/s41477-026-02265-0>
- [9] Marschner, P. (2012). *Mineral nutrition of higher plants*. Elsevier. <https://doi.org/10.1016/C2009-0-63043-9>
- [10] Broutin, J., & Meyer, C. (2025). Nitrate to spark parched plants. *Nature Plants*, *11*(11), 2192-2193. <https://doi.org/10.1038/s41477-025-02150-2>
- [11] V, V. N. S., & Rao, M. G. N. V. (2022). Formulation, development and characterization of an eco-friendly N-P-K fertilizer with multi micronutrient matrix. *Bioscience, Biotechnology Research Asia*, *19*(3), 787-795. <https://doi.org/10.13005/bbra/3031>
- [12] Venugopal, N. V. S., & Mohana Rao, G. N. V. (2021). A facile synthesis and characterization of new nitrogen, phosphorus, potassium (N-P-K) fertilizer fortified with tri-micronutrient matrix and its application for optimal plant augmentation. *Oriental Journal of Chemistry*, *37*(6), 1452-1457. <https://doi.org/10.13005/ojc/370626>
- [13] Agegnehu, G., Legesse, G., Tigabie, A., Desalegn, H., & Desta, G. (2025). *Integrated soil fertility management strategies for resilient soils in Ethiopia*.
- [14] Bureau of Statistics. (2019). *Agricultural production survey – Crops*. Maseru.
- [15] Bureau of Statistics. (2023). *Agricultural production survey – Crops*. Maseru.
- [16] Morojele, M. E., & Sekoli, M. S. (2016). Trend analysis of maize production in Lesotho and its distribution among the ecological zone. *European Journal of Agriculture and Forestry Research*, *4*(3), 1-4.
- [17] Food Agriculture Organization. (2020). *FAOSTAT*. Rome.
- [18] FAOSTAT. (n.d.). *Food and agriculture data*.
- [19] International Fertilizer Development Center. (2023). *Fertilizer fact sheet 2023: Tanzania*.
- [20] FAO. (2022). *Cropland nutrient budget – Global, regional and country trends, 1961–2020*. Rome.
- [21] Makochehanwa, A. (2023, April 27). Low-capacity hits fertiliser industry. *Business Times*.
- [22] Mtangadura, T. J., Mtambanengwe, F., Nezomba, H., Rurinda, J., & Mapfumo, P. (2017). Why organic resources and current fertilizer formulations in Southern Africa cannot sustain maize productivity: Evidence from a long-term experiment in Zimbabwe. *PLoS One*, *12*(8), e0182840. <https://doi.org/10.1371/journal.pone.0182840>
- [23] World Bank Group. (n.d.). *Fertilizer consumption (kilograms per hectare of arable land)*.
- [24] M, D., O, M. W., & N, S. N. (2021). The effects of organic liquid fertilizer (vegetable waste) on moisture retention, soil physical properties and yield of lettuce (*Lactuca sativa* L.) grown in the Malkerns Area, a region in the Kingdom of Eswatini. *Advances in Agriculture, Horticulture and Entomology*, *2021*(05). <https://doi.org/10.37722/AAHAE.2021502>
- [25] FAO. (2023). *World food and agriculture – Statistical yearbook 2023*. <https://doi.org/10.4060/cc8166en>
- [26] Bureau of Statistics, L. (2022). *Lesotho agricultural situation report*. Maseru.
- [27] Motlhwa, G., James, M. Y., & Yunxian, Y. (2019). Effects of Integrated Support Programme for Arable Agricultural Development (ISPAAD) on the income of sorghum farmers: Evidence from Kweneng District, Botswana. *Asian Journal of Agricultural Extension, Economics & Sociology*, 1-10. <https://doi.org/10.9734/ajaees/2019/v36i130234>.