**TITLE:**  **KE-Expo Crop Recommender**

Deployed Model Link: <https://brc0d3s.shinyapps.io/KE-CashCropRecommendation/>

Project Repository Link: <https://github.com/brc0d3s/Analyzing-and-Forecasting-Kenya-Agricultural-Exports-Using-Data-Science.git>

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**PHASE 1**

# 1. Introduction

Agriculture is the main sector in the Kenyan economy as it contributes about one third of the GDP and supports more than forty percent of the population. In the rural areas this figure is even higher thus underlining the importance of this sector in the food security. Kenya is also among the leading producers and exporters of others. agricultural However, products this and sector crops has including its tea, own coffee, challenges horticultural including crops and fluctuating flowers weather among conditions, fluctuations in global markets and improper utilization of resources.

Since the global economies are now shifting towards the use of data to make decisions, data science can be used to solve the challenges in agriculture. Through data, the it analysis is of possible big for stakeholders to make better decisions with an aim of enhancing agricultural output, predicting the trends in exports and coping with the shifts in market trends. The project aims at applying data science concepts on Kenya’s agricultural export sector, especially on the export trend forecasting to support decision making and increase the sector’s yield to the economy.

# 2. Problem Statement

The agricultural export sector, though critical to the Kenyan economy, faces many persistent challenges that diminish effectiveness and profitability:

1. **Market Volatility**: Market Volatility: Exporters often have to face fluctuating global demand and prices, making it very difficult to plan and realize maximum profits.
2. **Climate Uncertainty**: Climate Uncertainty: Uncertain weather patterns significantly influence agricultural yields, affecting supply chains and export volumes.
3. **Limited Data for Informed Decision Making:** Most of the stakeholders operate on limited data and thus often rely on mere guesses or incomplete information, which leads to inefficient production and resource allocation.

Data science brings solutions to such challenges through the analysis of historical data, forecasting future trends, and providing actionable insights to farmers and exporters. This project seeks to address these challenges by using data science in the provision of accurate export forecasts to stakeholders for better decision-making on production, distribution, and resource allocation.

# 3. Research Questions

The above-mentioned challenges will be addressed by the project in terms of the following research questions:

1. **What are the major trends in Kenya's agricultural exports over the last decade?** This will reveal the historical patterns and seasonal variations of Kenya's export commodities.
2. **What external factors-most notably, global demand, exchange rates, and climate conditions-best explain the variation in agricultural exports?**

Knowing these factors will help stakeholders prepare for and hedge against risks arising from export volatility.

1. **How can predictive models be applied to forecast future export trends for Kenya's key agricultural commodities?**

The question seeks to apply the time series models to generate an accurate forecast of future export values.

1. **What role can real-time data collection and analysis play in supporting Kenyan farmers and exporters in decision-making?**

The question will explore how real-time data can help make production and distribution decisions by stakeholders and adapt quickly to market changes.

1. **What data-driven strategies and policies can be recommended to enhance the export performance of Kenya's agricultural sector?**

Here, the focus is on translating data insights into actionable strategies that can boost export efficiency and profitability.

# 4. Justification

The agricultural sector in Kenya operates within a very uncertain and unpredictable environment. The application of data science-driven approaches would significantly enhance decision-making processes and operational efficiency among the stakeholders concerned. This project is justified based on the following key reasons:

1. **Efficient Resource Utilization:** Data-driven insights may lead farmers and exporters to plan an optimal production level by efficiently using precious resources such as water, labor, and fertilizers.
2. **Risk Management:** Trends in exports can be predicted from historical data to help stakeholders prepare for market fluctuations or weather disruptions, thus limiting exposure to risk.
3. **Policy Guidance:** Data insights provided can help policymakers devise policies that favor export growth, access to markets, and agricultural sustainability.
4. **Increased Profitability:** With better predictions of global demand and optimal use of resources, players will contribute to increased profitability for the economy at large in Kenya.

The application of data science in the project offers an encompassing solution to several challenges facing Kenya's agricultural export market.

# 5. Methodology for Data Collection

This effort will collect and gather data from such authoritative sources as:

* **Online Databases and APIs**:

KILIMOSTAT API: Provides economic and agricultural statistics from the Kenyan agricultural production sector.

FAOSTAT (Food and Agriculture Organization): Offers statistics on world agricultural production, trade, and markets.

Kaggle API : India based crop performance metrics data from Kaggle.

* **Web Scraping**:

Real-time data will also be gathered from Kenya National Bureau of Statistics website to capture up-to-date information on Kenyan agricultural production rates.

# 6. Conclusion

This is a very big opportunity for Kenya in the agricultural export sector, using data science. In that spirit, this project undertakes analysis of historical data and future trends with the aim of generating actionable insights for farmers, exporters, and policymakers. The role of Data Science can really make the Agricultural Sector much more efficient and profitable towards better economic growth for Kenya.

**PHASE 3**

# Insights From Data Analysis

Based on the detailed analysis undertaken in Phase 2 of the project, the following are some of the key findings:

1. **Trends in Agricultural Exports**

Kenya's agricultural export trend exhibits clear seasonality, with huge spikes in specific quarters arising from harvesting patterns, for example, tea and coffee exports peak in Q2 and Q4 annually.

1. **Key Influencing Factors:**

* Global Demand: Prices of tea and coffee are influenced to a great extent by and closely associated with changes in global demand, particularly from major markets in Europe and Asia, which remain important determinants of these price trends.
* Climate Variability: The rainfall patterns have been increasingly becoming unpredictable, while the temperatures keep rising, which together have a bad effect on the yields of horticultural crops.
* Exchange Rates: The values associated with exports can be significantly affected by the volatility in the USD-KES exchange rate, hence the need for putting in place financial hedging methods.

In particular, machine-learning models, including methods such as linear regression and ARIMA, which are specially designed for time-series analysis, excel at making trustworthy and accurate predictions. In fact, more specifically, the models showed a mean absolute error of about 5% on quarterly export prediction, reflecting their effectiveness.

With real-time data collection, farmers can drastically reduce uncertainty and therefore adapt planting schedules to market conditions and climate forecasts.

# Responses to the Research Questions

1. **Major and leading trends recognized in the agricultural exports of kenya**

Over the past decade, there has been a constant and very robust growth in the value of agricultural exports from Kenya. Tea, coffee, and flowers have contributed significantly to this development, as these three together account for a value share of over 60% of the total export value. Moreover, seasonal patterns show clear peaks in exports during May and June and in October and November.

1. **Exogenous Factors Influencing the Volatility of Export Performance**

The main ones are:

* + The relationship between global demand and market access is strongly interlinked with the export revenue generated.
  + Exchange rate fluctuations: A weakening of KES will decrease the exporter's profits denominated in USD payments.
  + Climate conditions: Reduced rainfall negatively impacts tea and coffee production by 15-20%.

1. **Applying Predictive Models to Export Trend Analysis**

By using the ARIMA and Random Forest models, we developed an accurate forecast for quarterly export trends to lead business decisions in production. For example, it's predicted that there will be an 8% rise in tea exports during Q2(Second Quarter) of 2025.

1. **Role of Real-Time Data in Decision-Making**

Coupled with the real-time weather information, this provides valuable data that enables farmers to properly plan their planting cycles while exporters are able to adjust shipment schedules according to expected demand for the products.

1. **Data-Driven Strategies to Improve Export Performance**

Strategies include:

* + Use the application of precision agriculture in enhancing the way resources are utilized.
  + Setting various financial instruments, such as forward contracts, in order to mitigate exchange rate risks.
  + Implement data-driven crop rotation schedules to increase productivity.

# Recommendations

1. Addressing the issues of data availability will help considerably to enhance the accuracy and credibility of forecasts
2. Climate-resilient agricultural practices should be followed to maintain export volumes.
3. Empower the farmers and exporters with full training in data literacy skills that enables them to use and benefit from real-time data.
4. Increase substantially the funding for agricultural research and development projects to improve productivity and enhance the resilience of our agricultural systems.