Crop Yield in Kyrgyzstan

Introduction

The economy of Kyrgyzstan, a landlocked nation in Central Asia, is heavily reliant on agriculture. A sizable section of the populace makes their living from farming and raising animals. Agricultural production becomes an important problem for national development because of the difficulties posed by mountainous terrain, a continental climate, and the changing effects of climate change.

The purpose of this research was to investigate the effects of agricultural and environmental variables, including temperature, precipitation, and pesticide use, on crop productivity in Kyrgyzstan. The objective is to comprehend past trends and spot patterns that can help forecast the future and guide the formulation of agricultural policies.

Data Description

The analysis utilizes multiple datasets compiled from official sources and international databases:

- **Crop Yield Dataset:** Yearly data for crop yield in quantile per hectare.
- **Temperature Data:** Annual average temperatures (1985-2024).
- **Rainfall Data:** Average rainfall in millimeters per year.
- **Pesticide Usage Data:** Total pesticide use in tons annually.

Each dataset includes a 'Year' and ‘Area’ columns for merging, and most are focused on the Kyrgyz Republic. Missing values were handled using interpolation (linear or forward fill depending on context), especially where gaps occurred in temperature, rainfall, or pesticide use.

Exploratory Data Analysis (EDA) revealed several trends:

- **Temperature:** There is a steady upward trend in the average annual temperature, rising from approximately 1.6°C in the 1980s to over 4.3°C by 2024.
- **Rainfall:** Rainfall shows more fluctuation than temperature. While no clear trend is obvious, extremes (both highs and lows) appear more frequently in recent decades.The minimum amount of precipitation was recorded in 2021, after which the harvest was not so fruitful and food prices rose(it was the driest year in the past 40 years).
- **Pesticides:** Usage has significantly declined since the early 1990s, possibly due to shifts in agricultural practices, reduced government subsidies, or import constraints.
- **Yield:** Crop yield data correlates moderately with rainfall and weakly with temperature.

The dramatic drop in agricultural production numbers before 1995, particularly those of commodities like wheat, corn, and potatoes, is among the dataset's most striking trends. This decline is consistent with the early years of Kyrgyzstan's independence when the Soviet Union fell apart in 1991. Crop yields and farm production suffered as a result of the shift,

which also brought about economic instability, the demise of centralized farming systems, and restricted access to agricultural inputs.

Following 1995, we saw a recovery and a slow rise in crop production, most likely as a result of government reforms, market adaptation, and agricultural sector stabilization. Around 2021, there is a noticeable decline once more, which could be caused by regional environmental reasons or worldwide disturbances like the COVID-19 pandemic.

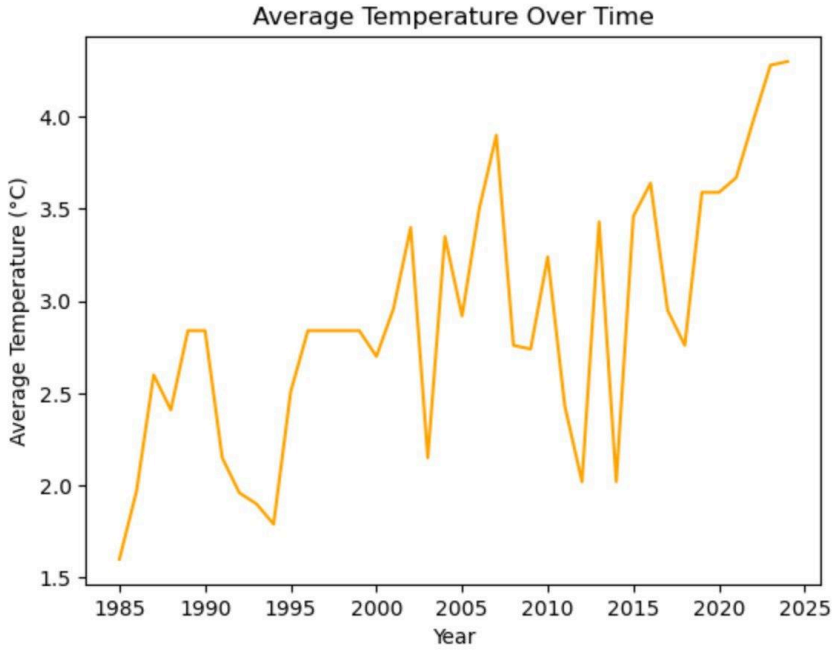
Specifically for pesticide usage, the data shows that levels continued decreasing after 1995 and reached their lowest point around the late 2000s. A slow recovery is observed starting around 2010, possibly due to gradual improvements in infrastructure, market access, and the adoption of more sustainable farming practices.

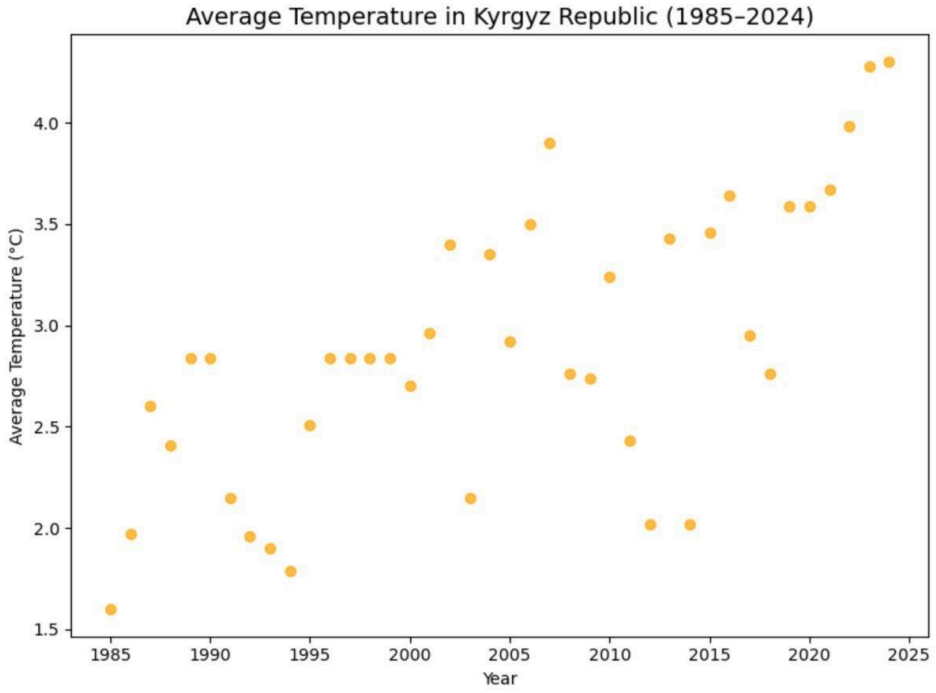
Correlation Analysis:

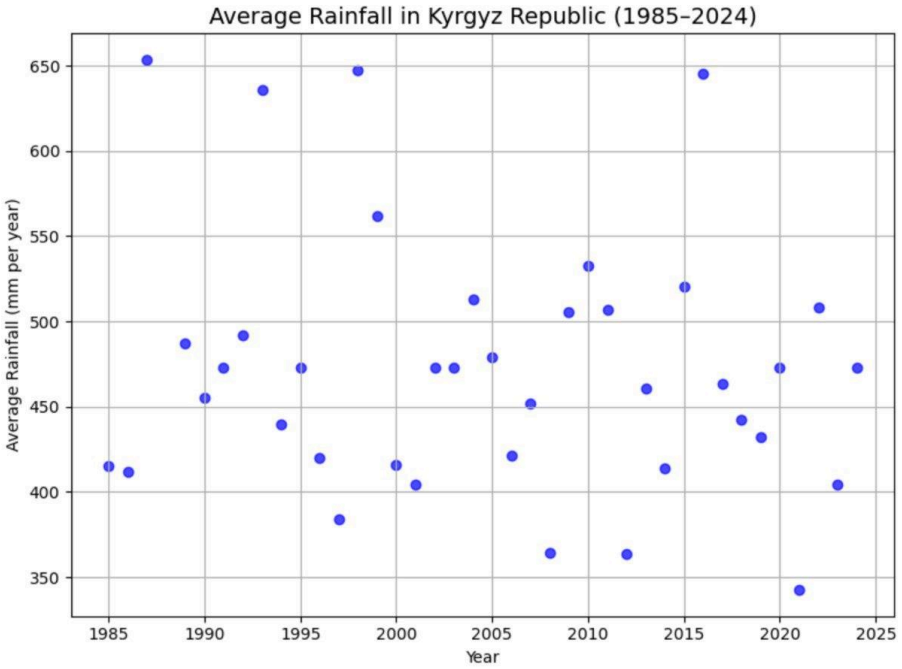
- Yield vs. Rainfall: ~0.48 (moderate positive correlation)
- Yield vs. Temperature: ~-0.22 (weak negative correlation)
- Yield vs. Pesticides: ~0.33 (low to moderate correlation)

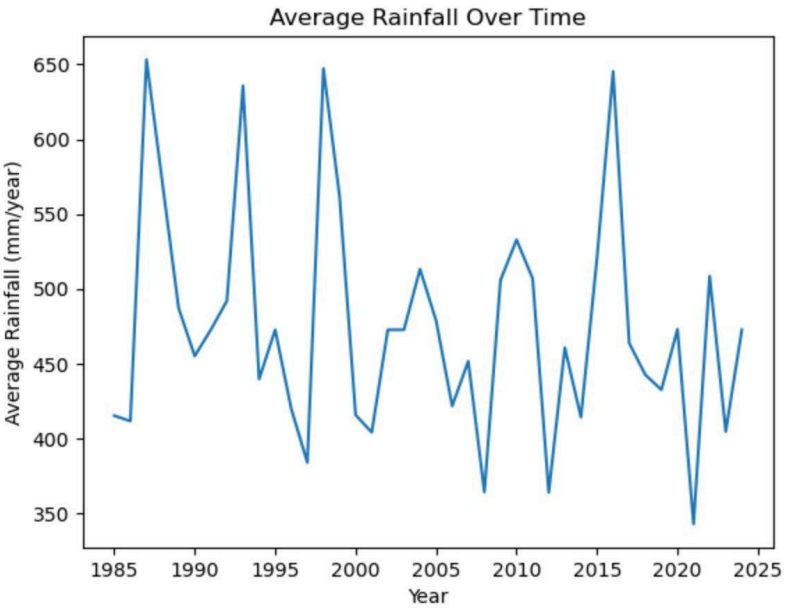
Visualizations

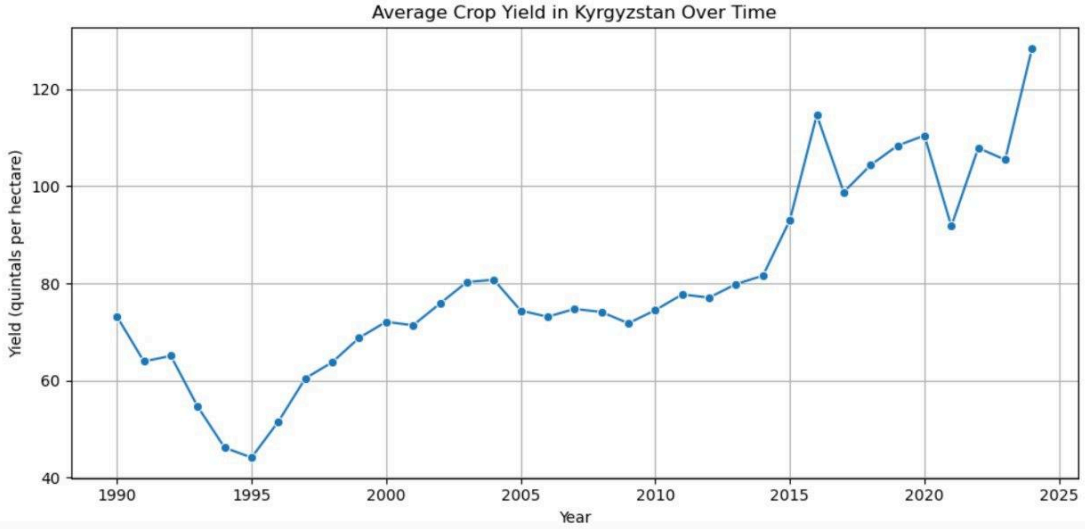
- **Line Plots:** Temperature and rainfall trends over time clearly illustrate climate variability.
- **Scatter Plots with Regression Lines:** Used to visualize relationships between yield and environmental variables.
- **Bar Charts:** Show items distribution by category (wheat,potato, etc.).



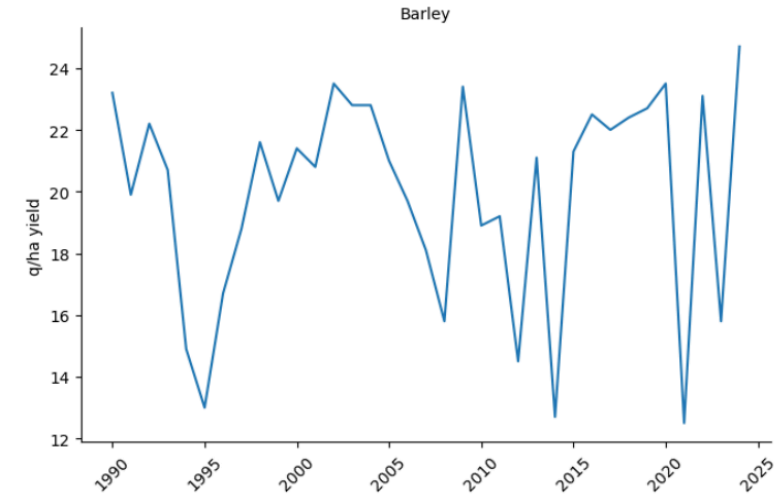

Average Temperature in Kyrgyz Republic (1985–2024)
Average Temperature (°C)
Year
1.5
2.0
2.5
3.0
3.5
4.0
1985
1990
1995
2000
2005
2010
2015
2020
2025

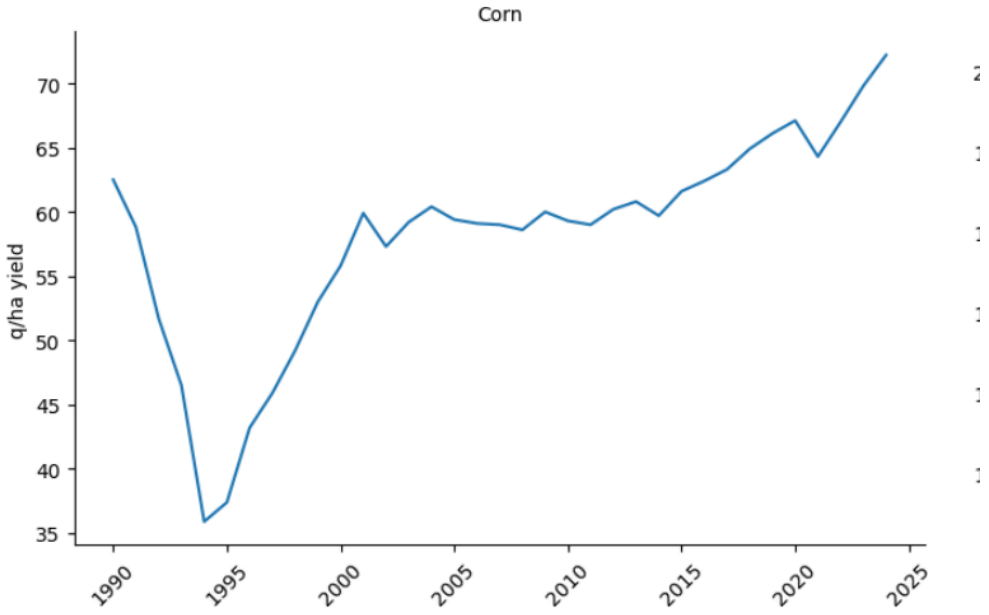

Average Rainfall in Kyrgyz Republic (1985–2024)
Average Rainfall (mm per year)
Year
350
400
450
500
550
600
650
1985
1990
1995
2000
2005
2010
2015
2020
2025

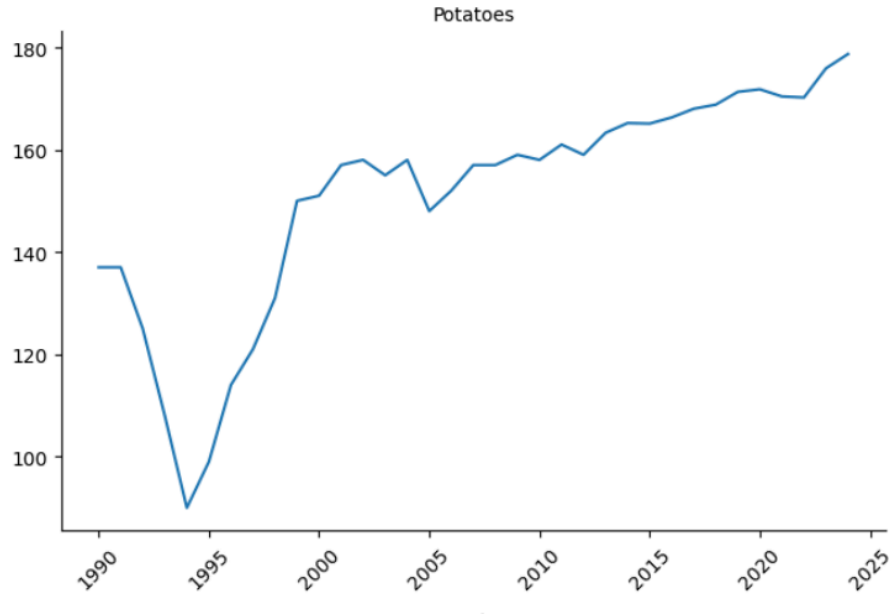

Average Rainfall Over Time
Average Rainfall (mm/year)
650
600
550
500
450
400
350
1985
1990
1995
2000
2005
2010
2015
2020
2025
Year


Average Crop Yield in Kyrgyzstan Over Time
Yield (quintals per hectare)
120
100
80
60
40
1990
1995
2000
2005
2010
2015
2020
2025
Year

The visualizations clearly illustrate a significant decline in agricultural output and pesticide usage prior to 1995, followed by a noticeable upward trend in the subsequent years. This shift marks a turning point in Kyrgyzstan's agricultural sector, likely influenced by the broader political and economic changes during the early post-independence period.







Conclusion

This project highlights the complex interplay between climatic factors and agricultural productivity in Kyrgyzstan. The increasing temperature and fluctuating rainfall pose a challenge for consistent yield output. The decrease in pesticide use may indicate a shift to organic or less chemical-intensive farming, but it might also reduce yield if not balanced with alternative methods.

The findings can inform policies aimed at climate adaptation, efficient resource allocation, and sustainable agriculture. Future work should incorporate more granular crop-specific data, economic factors (e.g., subsidies, imports), and satellite-based land use monitoring.

References(sources)

- National Statistics Committee of Kyrgyz Republic
- World Bank
- Kaggle
- FAOSTAT (FAO)
- Trading Economics