The Journal of Resilient Urbanism and Sustainable Design

The publication of the Journal of Resilient Urbanism & Sustainable Design (JRUSD | ISSN: 3067-6029) aligns with its mission to advance interdisciplinary research in sustainable development, urban resilience, environmental sustainability, and socio-ecological systems. JRUSD seeks original and innovative papers that substantially enhance theoretical understanding, methodological approaches, or empirical insights within the fields of sustainable urbanism, spatial planning, ecological preservation, and biocultural diversity.

The Journal of Resilient Urbanism & Sustainable Design serves as an international, peer-reviewed, open-access platform for scholars, practitioners, and policymakers to exchange knowledge, promote best practices, and develop innovative interdisciplinary solutions. Contributions are welcomed from diverse geographic contexts, emphasizing research that strengthens resilience and adaptive capacities in urban environments, while simultaneously addressing global sustainability challenges. JRUSD is published regularly, ensuring timely dissemination of critical research findings and discussions.

Received: October 28, 2025
Revised: December 03, 2025
Accepted: December 20, 2025
Published: December 26, 2025

Research Article

Exploring the Relationship Between Annual Rainfall Variability and Selected Urban Crop Output in Jos Metropolis

Kingsley Chibuzor Fredricks[1*], Simi S. Goyol[1]

[1] Department of Geography and Planning, Faculty of Environmental Sciences, University of Jos, P.M.B. 2084, Jos, Plateau State, Nigeria

[*] Correspondence: Kingsleyfredricks@gmail.com

Abstract: This study investigates the relationship between annual rainfall variability and the output of three key urban crops, maize, tomato and potato, in Jos Metropolis, Nigeria, from 2012 to 2023. The study utilized rainfall data from 1994 to 2023 and crop yield data from 2012 to 2023. Using Pearson correlation and linear regression, the analysis assessed the degree to which annual rainfall influenced crop yields. Results revealed significant fluctuations in rainfall over the years, with the highest level recorded in 2019 and the lowest in 2007. However, statistical analysis showed weak and insignificant correlations between rainfall and the output of maize ($r = 0.012$), tomato ($r = 0.146$) and potato ($r = 0.151$). Despite these fluctuations, maize and tomato yields showed a steady increase, suggesting that improvements in farming practices, access to better seeds and small-scale irrigation may have offset the effects of rainfall variability. Potato output experienced a dip due to late blight disease between 2013 and 2017 and then showed a sharp recovery. The findings demonstrate that while rainfall plays a role in crop productivity, other factors such as soil quality, pest control and adaptive techniques are equally important. The study highlights the importance of climate-smart agriculture, effective water management and targeted government support. It recommends investment in urban farming infrastructure, improved weather forecasting and farmer training to build resilience and ensure sustainable food production in Jos Metropolis.

Keywords: Rainfall Variability; Annual Rainfall; Urban Agriculture; Crop Yield; Jos Metropolis

Highlights:

- Assessed rainfall variability and crop production trends in Jos Metropolis (1994–2023), finding inconsistent changes in annual rainfall and fluctuating crop outputs that were not consistently linked to rainfall patterns.
- Identified that rainfall variability alone does not fully explain crop yield fluctuations, suggesting that other factors beyond rainfall influence urban farming productivity in Jos.
- Recommended practical adaptation strategies for farmers, including improved water management (rainwater harvesting and drip irrigation), drought-tolerant and diversified cropping systems, and enhanced access to weather information and training.

- Emphasized the need for supportive government policies and planning, such as allocating land and financial resources to urban farmers and integrating weather services into agricultural decision-making.

1. Introduction

Rainfall is a key climatic factor that significantly influences agricultural production across the world. Rainfall is a common form of precipitation in tropical regions, it involves the descent of liquid water droplets from the atmosphere to the Earth's surface, typically measuring between 1 and 5 millimeters in diameter. The characteristics of the rainfall produced are largely determined by the specific atmospheric condition under which it forms (Chinago, 2020). Rainfall variability refers to the instability in the occurrence of rainfall, whether annually or seasonally, compared to a long term mean over a specific period (Ogundari et al., 2021). Rainfall variability impact the sustainability of water resources, influencing their availability, management, and use. These changes can subsequently affect ecosystems, land productivity, agriculture, food security, water supply, and human health (Abegaz & Mekoya, 2020). Agriculture in Nigerian agriculture is predominantly rain-fed even where irrigation has been strictly operational, most schemes still rely on predictable rainfall patterns for effectiveness particularly because of surface and groundwater recharge (Shanono et al., 2022). Over the past decade, all Agroecological Zones (AEZs) in Nigeria have experienced increasingly erratic rainfall patterns during the planting seasons (Adeaga et al., 2022; Clinton & Chinago, 2021). Recent findings indicate that many farming seasons are marked by early but misleading rainfall onsets, prolonged dry spells, and delayed cessations accompanied by intense rainfall that often leads to flash floods (Olayide et al., 2024). This growing unpredictability has made it difficult to precisely determine the onset and end of planting periods. As a result, farmers struggle to align their agricultural calendars with actual rainfall trends (Edokpa et al., 2023). According to Zitta & Madaki (2020) (Zitta & Madaki, 2020), the evolving pattern of rainfall variability signals an evolving environmental scenario, with potential implications especially on urban agriculture which in turn can greatly impact crop yield leading either to food security of insecurity.

Urban agriculture is a multifaceted concept encompassing a wide range of livelihood strategies, from small-scale household food production and processing to larger, market-oriented farming operations (Chenarides et al., 2020). The USDA (2020) (USDA, 2020) describes urban agriculture as encompassing various practices such as gardening on rooftops, balconies, and backyards, as well as community gardens in vacant lots, parks, and even roadside or urban fringe areas, including livestock grazing in open spaces. In Jos Metropolis, where urban agriculture is practiced on small and empty plots of land, rainfall variability significantly affects crop yields. It is also important to note that Jos Metropolis, like many urban areas, faces unique challenges related to urbanization, land use change, and population growth. Urbanization leads to the conversion of agricultural land into built-up areas, which can reduce the land available for farming. As the population of Jos continues to grow, understanding how rainfall variability impacts urban crop output becomes even more important for ensuring food security in the region. The significance of this study extends beyond the local context of Jos Metropolis. As Nigeria continues to face challenges related to food security, understanding the factors that influence crop output in urban areas is crucial. This paper focuses on exploring the relationship between rainfall variability and its effects on urban food security. With an increasing urban population and limited farmland, understanding how rainfall patterns impact some selected crop output is essential. The research focuses on the period 2012–2023 for crop data and 1994–2023 for rainfall patterns, providing a long-term view of climate trends and agricultural responses in an urban setting.

2. Materials and Methods

2.1. Study Area

Jos metropolis is situated within the latitudinal coordinates of 9°54' N to 10°10' N and longitudinal coordinates of 8° 48'E to 9° 30'E. The region lies within the northern senatorial district of Plateau State, bordered by Barkin-Ladi and Jos East to the east, Riyom to the south, and Bassa local government areas to the west. The spatial expanse of Jos metropolis spans approximately 104km from north to south and around 80km from east to west, with an elevation of 1,250m above sea level. Shere Hills boasts the highest summit, reaching 1,777m above sea level, covering an area of 1002.19 square kilometers (Akintunde at el., 2016). The average yearly temperature in Jos fluctuates between 20°C and 26°C. These temperature variations occur as a result of various factors such as rainfall, terrain, and cloud cover, which vary across different times and seasons throughout the year. Relative humidity decreases during the dry season from November to March but rises significantly during the wet season, reaching peak levels of 81% to 84% in July and August (Sufiyan at el., 2020). The average rainfall for Jos metropolis is around 1,411mm per year. Jos has 181.54 rainy days (49.74% of the time) annually, while the days with no rain is about 183.46 (50.26%). The study area experiences distinct wet and dry seasons. The wet season spans approximately 7 to 8 months, starting from mid-March and extending to the end of November, while the dry season persists for about 5 to 6 months, commencing from mid-November and lasting until mid-May (Zitta at al, 2020)

2.2. Data sources

Rainfall data were obtained from the University of Jos Meteorological Weather Station. The dataset included daily and monthly rainfall records spanning 1994-2023. For this study, monthly rainfall values were aggregated to calculate annual rainfall totals which were used to assess rainfall variability over the years. Crop output data for maize, tomato, and potato were retrieved from the Plateau Agricultural Development Program's reports. These reports provided annual crop yield measurements in metric tons per hectare for the period 2012-2023. The collected data enabled a year-by-year comparison of crop production and help establish the relationship between rainfall variability and urban agricultural output in Jos metropolis.

2.3. Analytical Techniques

Pearson correlation coefficients was first used to assess the strength and direction of associations between rainfall and each crop's output. Furthermore, a regression analysis was performed to model the impact of rainfall as an independent variable on crop yields, enabling the identification of statistically significant relationships and potential predictive insights.

For the regression analysis, a linear regression model is specified as follows:

$(y = \beta 0 + \beta 1x + \varepsilon)$

where:

(y) = Represents crop yield for maize, tomato, or potato, (Dependent variable)

(X) = Represents annual seasonal rainfall totals (Independent variable)

($\beta 0$) = Intercept or constant

($\beta 1$) = Slope or coefficient of rainfall's impact on crop output, and

(ε) = Error term, representing unexplained variability (Residual)

This model was applied to each crop individually to determine specific rainfall verses yield relationships for maize, tomato, and potato.

3. Results

3.1. Changes in land use of City in the period 1990-2020

Table 1 presents the annual rainfall in Jos Metropolis from 1994 to 2023 it indicates that rainfall varied significantly from year to year, showing both increasing and decreasing trends over different periods. In 1994, there was a drastic increase, followed by a slight decline in 1995. By 1996, the amount of rainfall remained high, though a downward trend started appearing. 1997 and 1998 continued this decline, with rainfall dropping further. 1999 and 2000 marked some of the lowest rainfall levels during this period, showing a sharp reduction compared to earlier years. As the 2000s progressed, rainfall began to fluctuate. 2001 and 2002 saw slightly improved rainfall levels compared to the late 1990s. However, 2003 and 2004 experienced another dip before 2005 and 2006 recorded moderate increases. In 2007, rainfall declined significantly, marking one of the lowest levels in the dataset. 2008 and 2009 saw a significant fluctuation. In the 2010s, rainfall continued to vary. 2010 and 2011 recorded moderate levels, followed by an increase in 2012, which saw another peak. 2013 and 2014 had slightly reduced rainfall, but 2015 and 2016 saw another rise. In 2016 to 2018, rainfall maintained a stable pattern. 2019 saw the highest peak of rainfall in the whole 31 years. 2020 witnessed a sharp decrease compared to the peak year. This downward trend continued into 2021, 2022, and 2023.

Overall, the data from 1994 to 2023 show significant rainfall variability, with alternating years of increase and decrease. The highest rainfall was recorded in 2019, while the lowest rainfall was recorded in 2007. The last few years (2019–2023) indicate a declining trend.

3.2. Analysis of Crop Output of Maize, Tomato, and Potato in Jos Metropolis

Table 2 presents present the annual crop output data for maize, tomato, and potato from 2012 to 2023. It indicated that there was changed in the three different crop output for the period of years under consideration. For maize, the highest output was recorded in 2023 while the lowest output was recorded in 2012. For tomato, the highest output was recorded in 2023 while the lowest output was recorded in 2012. For potato, the highest output was recorded in 2023 while the lowest output was recorded in 2016.

Table 1. Annual Rainfall amounts of Jos metropolis

Years	Annual Rainfall (mm)
1994	1731.07
1995	1,662.70
1996	1,696.40
1997	1,236.40
1998	1,142.80
1999	1,183.10
2000	1,409.40
2001	1,361.50
2002	1,196.10
2003	1,434.40
2004	1,550.90
2005	1,101.60
2006	1,565.80
2007	1,036.90
2008	1,470.70
2009	1,037.90
2010	1,553.50
2011	1,207.70
2012	1,633.40
2013	1,306.10
2014	1,694.20
2015	1,558.90
2016	1,379.00
2017	1,379.50

2018	1,491.40
2019	1,991.60
2020	1,037.00
2021	1,272.00
2022	1,269.20
2023	1,289.60

(Source: University of Jos meteorological weather station)

Table 2. Crop yield of Maize, Tomato and Irish Potato

Year	Maize	Tomato	Potato
2012	239.43	143.97	2526.87
2013	250.94	141.97	1904.12
2014	258.47	145.3	1768.74
2015	266.22	147.66	1821.8
2016	274.21	152.13	1632.17
2017	278.32	154.41	1656.65
2018	398.5	156.73	3060.27
2019	420.24	159.08	3310.27
2020	473.39	161.47	3359.89
2021	557.95	163.84	3409.49
2022	673.92	166.21	3459.09
2023	821.3	168.58	3508.69

(Source: Plateau Agricultural and Development Program (PADP))

3.3. Analysis of Maize Yield in Jos Metropolis (2012-2023)

Maize output in Jos Metropolis in table 2 indicated a steady increase over the years, showing a positive trend in production. In 2012, maize production started at around 250 tons. This output remained relatively stable in 2013, 2014, 2015, 2016, and 2017, fluctuating slightly but staying within the 250 to 300-ton range. During this period, there was no significant increase in production, suggesting that maize farming faced certain limitations, such as unfavorable weather conditions or stagnant farming practices. However, in 2018, the output began to rise, reaching approximately 350 tons. This upward trend continued in 2019, with production increasing to around 400 tons. By 2020, the output had grown to about 473 tons, showing consistent progress. In 2021, maize production further increased to 557 tons, marking a significant improvement. A notable surge occurred in 2022, as the output rose to around 673 tons. This trend continued into 2023, with production reaching nearly 821 tons, the highest level recorded in the period under review. This trend indicates a promising future for maize production in the area.

Findings in figure 1 indicates that maize output has maintained a consistent uptrend over the years. The years with highest yields may be linked to either favorable weather conditions, such as increased rainfall during the growing season, or improved farming practices. For example, figure 1 indicates a peak from 2021 to 2023, it could suggest that the rainfall and climate conditions in that year were ideal for maize cultivation, resulting in higher outputs.

3.4. Analysis of Tomato Yield in Jos Metropolis (2012-2023)

The annual tomato output in Jos Metropolis in figure 2 indicates a steady and consistent increase over the years. In 2012, the output was around 143 tons. This production level remained relatively stable in 2013, with only a slight increase. By 2014, the output had risen slightly above 145 tons, marking the beginning of a gradual upward trend. In 2015, production continued to increase, reaching approximately 147 tons. This growth persisted into 2016, where the output surpassed 152 tons. By 2017, tomato production had further improved, reaching around 154 tons. This positive trend continued in 2018, with the output increasing slightly beyond 156 tons. In 2019, production climbed to about 159 tons, followed by another increase in 2020, where the yield approached 161 tons. From 2021 onward, tomato output saw more notable growth. In 2021, production reached approximately 163 tons, followed by an increase to around 166 tons in 2022. By 2023, the output had reached its highest level during this period, standing at nearly 168 tons. Findings indicates a consistent upward trend in tomato production, with gradual but steady increases each year.

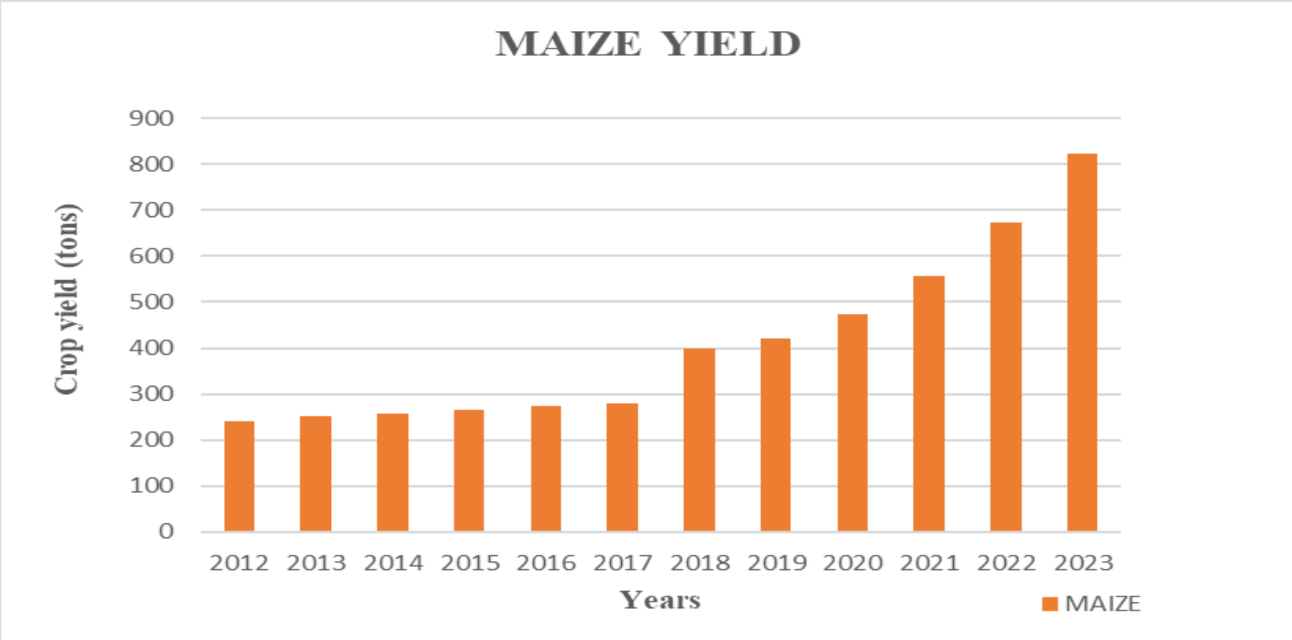

Figure 1. Maize annual output in Jos metropolis from 2012-2023

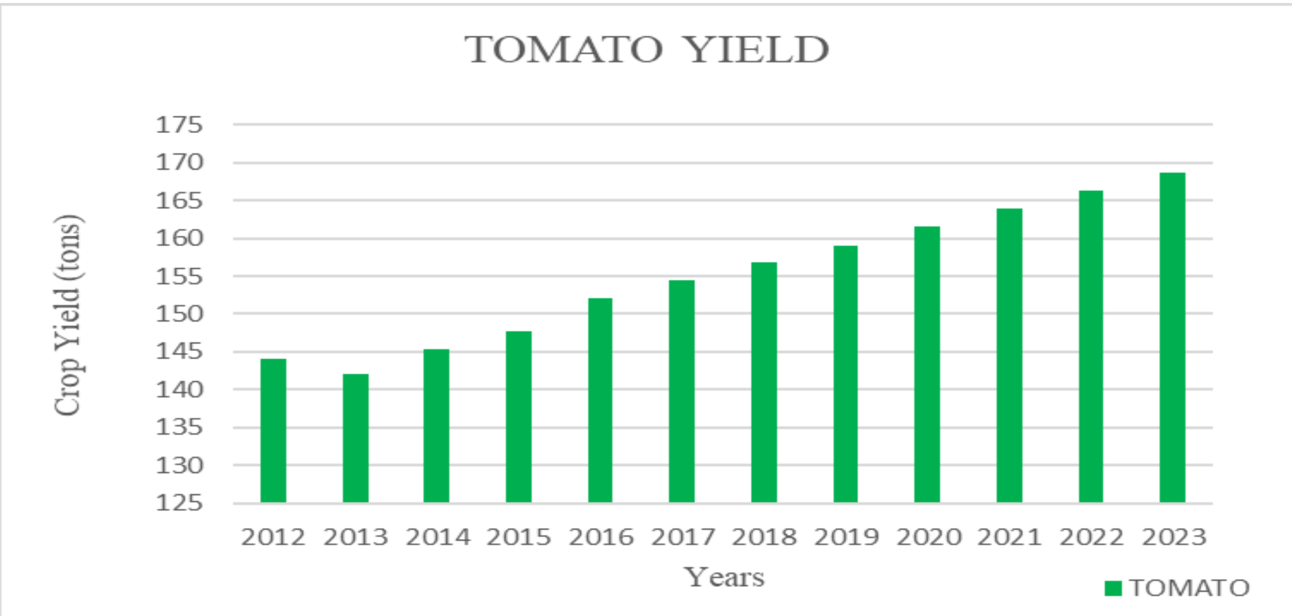

Figure 2. Tomato Annual output in Jos metropolis from 2012-2023

Tomatoes are a more delicate crop than maize and are particularly susceptible to temperature and rainfall changes. In years with adequate rainfall, the tomato output tends to be higher. However, if there is too much rainfall or too little, it can harm the crops, leading to lower outputs. In this case, figure 2 indicates a stable increase in tomato production in some years, especially when weather conditions are just right. A decrease in tomato yield, on the other hand, could point to factors such as excessive rainfall, disease, or pest infestations that typically affect tomatoes. These challenges demonstrate the vulnerability of tomato farming to environmental changes and how farmers must adapt their strategies to mitigate these risks.

3.5. Analysis of Potato output in Jos Metropolis (2012-2023)

The potato yield in Jos Metropolis experienced fluctuations over the years, with notable changes in production levels. In 2012, the yield was relatively high, reaching approximately 2,500 tons. However, in 2013, there was a decline as production dropped to less than 2,000 tons. This downward trend continued into 2014, where the yield remained slightly above 1,800 tons. In 2015, the production level showed little improvement, staying within a similar range. By 2016, the yield further decreased to its lowest point within this period, at around 1,500 tons. The year 2017 saw a slight recovery, but production levels still hovered around the 1,500-ton mark. A significant change occurred in 2018, as the yield increased sharply to approximately 3,000 tons. This marked a turning point, with potato production maintaining a steady rise. In 2019, the yield increased further, nearing 3,200 tons. This positive trend continued into 2020, 2021, 2022, and 2023, where the production remained consistently high at around 3,500 tons. The data indicates an initial decline in potato yield from 2012 to 2017, followed by a remarkable recovery from 2018 onward.

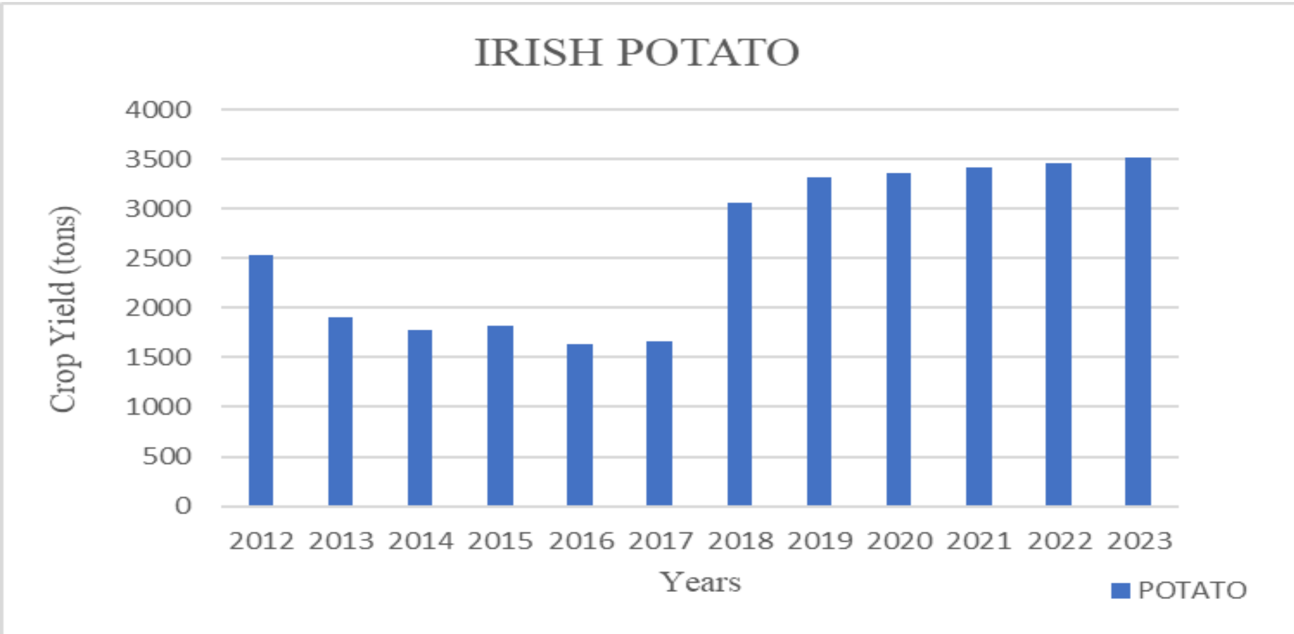

Figure 3. Potato Annual Output in Jos metropolis from 2012-2023

Findings in figure 3 indicates a decline in Potato production from 2014 to 2017. When comparing findings of the three selected crops, output of maize and tomato in Jos Metropolis maintained a consistent upward trend. From all indication, rainfall is not only the major contributor to the fluctuation of crop output in the study area. Findings reveal that there was an increase in crop output for maize, tomato, and potato in Jos Metropolis between 2012 and 2023. The fluctuating yields are likely influenced by a combination of weather conditions, including rainfall and temperature, as well as farming practices. By understanding these trends, farmers can better plan for future growing seasons and work towards improving crop yields, ensuring food security, and sustaining the agricultural economy in the study area.

3.6. Relationship between rainfall variability and crop yield

Table 3 presents the correlation between rainfall and the output of maize, tomato, and potato. Findings indicate that rainfall has little effect on crop output, with weak and non-significant correlations: 0.012 for maize, 0.146 for tomato, and 0.106 for potato.

Table 3. Correlation is significant at the 0.01 level (2-tailed)

		Rainfall	Maize Yield	Tomato Yield	Potato Yield
Rainfall	Pearson Correlation	1	.012	.146	.106
	Sig (2-tailed)		.949	.443	.576
	N	30	30	30	30
Maize Yield	Pearson Correlation	.012	1	.898**	.955**
	Sig (2-tailed)	.949		000	000
	N	30	30	30	30
Tomato Yield	Pearson Correlation	.146	.898**	1	.952**
	Sig (2-tailed)	.443	000		000
	N	30	30	30	30
Potato Yield	Pearson Correlation	.106	.954**	.952**	1
	Sig (2-tailed)	.576	000	000	
	N	30	30	30	30

3.6.1. Correlation for Maize yield and Rainfall

Table 4 presents the Pearson correlation coefficient for maize yield and rainfall as 0.012, which is very close to zero. This indicates virtually no linear relationship between rainfall and maize yield. The p-value (0.475) is significantly higher than the standard threshold of 0.05, meaning the correlation is not statistically significant.

Table 4. Correlations for maize output and rainfall

		Maize Yield	Rainfall
Pearson Correlation	**Maize Yield**	1.000	.012
	Rainfall	.012	1.000
Sig. (1-tailed)	**Maize Yield**	-	.475
	Rainfall	.475	-
N	**Maize Yield**	30	30
	Rainfall	30	30

The Pearson correlation coefficient between maize yield and rainfall is 0.012. This very low value close to zero suggests that there is virtually no linear relationship between maize yield and rainfall. The significance value (Sig.) is 0.475, which represents the probability of observing the correlation by chance if there were actually no relationship. A common threshold for statistical significance is 0.05. Since 0.475 is much higher than 0.05, the correlation is not statistically significant. This means we do not have enough evidence to conclude a real relationship between maize yield and rainfall. The sample size, denoted by N, is 30 for both maize yield and rainfall. This is the number of paired observations used to calculate the correlation coefficient. The correlation coefficient of 0.012 suggests no meaningful linear relationship between maize yield and rainfall in this dataset. Additionally, the p-value of 0.475 indicates that this result is not statistically significant. Therefore, changes in rainfall do not appear to have a measurable impact on maize yield in this particular data.

3.6.2. Correlation for Tomato output and Rainfall

Table 5 presents the Pearson correlation coefficient for tomato yield and rainfall as 0.146, indicating a weak positive relationship. While this suggests that higher rainfall may slightly increase tomato production, the relationship is not strong. The p-value of 0.221 is again above the 0.05 threshold, signifying that the correlation is not statistically significant.

Table 5. Correlation coefficient for Tomato and Rainfall

		Tomato Yield	Rainfall
Pearson Correlation	**Tomato Yield**	1.000	.146
	Rainfall	.146	1.000
Sig. (1-tailed)	**Tomato Yield**		.221
	Rainfall	.221	
N	**Tomato Yield**	30	30
	Rainfall	30	30

The Pearson correlation coefficient between tomato yield and rainfall is ($r = 0.146$). This is a weak positive correlation, suggesting that as rainfall increases, tomato yield tends to increase slightly. However, the relationship is not strong enough to imply a substantial association. The significance level (p-value) for this correlation is 0.221. Since this value is greater than the commonly used threshold of 0.05, the correlation between tomato yield and rainfall is not statistically significant. This suggests that any observed association might be due to random chance rather than a meaningful relationship. The analysis was conducted with a sample size (N) of 30. While there is a slight positive correlation between rainfall and tomato yield, the association is weak and not statistically significant, indicating that rainfall alone may not be a strong predictor of tomato yield in this dataset. Other factors, such as soil quality, farming practices, or other environmental variables, could be explored to better understand yield variability.

3.6.3. Correlation for Potato yield and Rainfall

Table 6 presents the Pearson correlation coefficient for Potato as 0.151, indicating another weak positive correlation. Similar to tomatoes, potato production shows a slight tendency to increase with higher rainfall, but the effect is minimal. The p-value (0.217) is above the 0.05 threshold, making the relationship statistically insignificant.

The findings in table 6 indicate a weak positive correlation between the two variables, suggesting that as rainfall increases, potato yield may increase slightly, but this relationship is minimal and not strongly pronounced. The significance value for the correlation between potato yield and rainfall is 0.217. Since this p-value is greater than the conventional significance level of 0.05, we conclude that the correlation is not statistically significant.

The relationship between annual rainfall and crop output in figure 4 plays a crucial role in understanding agricultural productivity, especially in regions dependent on rainfall. The graph in figure 4 provides insight into the trends in annual rainfall (mm) and the output of maize, tomatoes, and potatoes (Tons) over a 30-year period, including their respective three-period moving averages. The annual rainfall data, represented by the blue line, shows significant fluctuations between 1994 and 2023. Maize yield, depicted by the yellow line, remains negligible until around 2012, when a sharp increase is observed. Following this surge, maize yield stabilizes and grows steadily from 2015 onwards, as indicated by its moving average. Tomato and potato yields follow a different trajectory. Both crops demonstrate gradual but consistent growth throughout the years. The tomato yield, represented by the light blue line, shows steady improvement, with its moving average confirming a relatively stable growth trend. Similarly, potato yield, shown in orange, exhibits slow yet progressive increases. Based on the findings, the data does not reveal a direct correlation between rainfall and crop yields.

Table 6. Correlation coefficient for Potato yield and Rainfall

		Potato Yield	Rainfall
Pearson Correlation	**Potato Yield**	1.000	.151
	Rainfall	.151	1.000
Sig. (1-tailed)	**Potato Yield**	.	.217
	Rainfall	.217	.
N	**Potato Yield**	30	30
	Rainfall	30	30

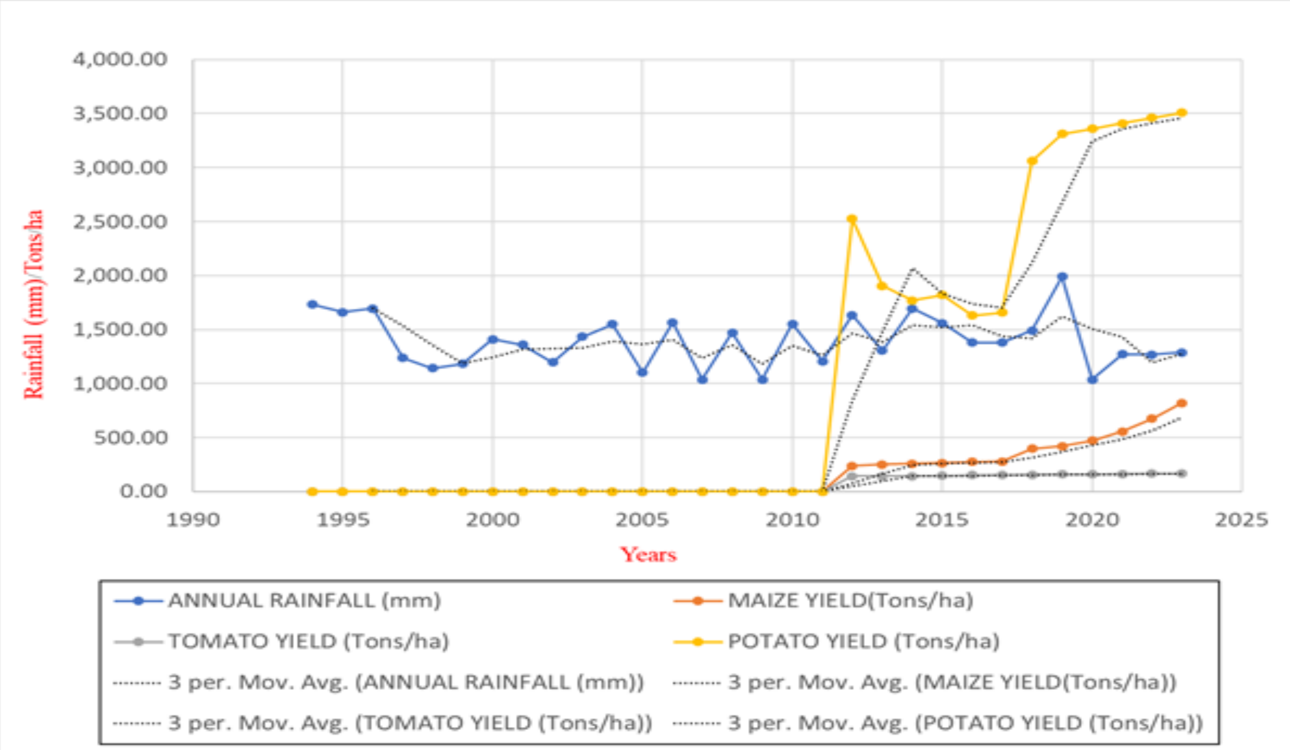

Figure 4. A combined linear trend between rainfall, maize, tomato, and potato

4. Conclusions

This study looked at how changes in rainfall affect farming in Jos Metropolis from 1994 to 2023. It examined rainfall patterns, how they impact crop production, and what the future might hold for rainfall in the study area. The findings show that while there has been a small decrease in annual rainfall over time, the changes are not consistent. Apart from rainfall changes, the study also explored urban farming in Jos. findings showed that there where records of fluctuations in crop output which were not necessarily influenced by rainfall. This study has shown that while rainfall changes affect farming in Jos, these challenges can be managed with the right solutions.

To help farmers in Jos Metropolis deal with changes in rainfall and keep urban farming productive, critical steps need to be taken. These recommendations focus on improving water management, choosing the right crops, providing better weather information, and supporting farmers through government policies and research.

1) Since rainfall is unpredictable, farmers should find ways to store and use water efficiently. This can be done through rainwater harvesting, where water is collected and stored during heavy rains for use during dry periods. Drip irrigation systems can also help by delivering water directly to the roots of plants, reducing waste and ensuring that crops get enough moisture even when rainfall is low.
2) Farmers should focus on growing crops that can handle dry conditions, such as millet and certain types of beans. Mixing different types of crops in the same farmland can also help, as some crops may do better when rainfall is high while others perform well when it is low. This approach reduces the risk of losing an entire harvest due to unpredictable weather.
3) Many farmers rely on experience to predict rainfall, but with climate changes, past patterns are no longer reliable. The government and weather agencies should work together to provide easy-to-understand weather updates through radio, text messages, or community meetings. Training programs can also help farmers learn how to use weather information to plan their farming activities more effectively.
4) Government support is also necessary to help farmers deal with the challenges of urban agriculture. Authorities should create policies that make it easier for farmers to get land, water, and financial support. Many urban farmers struggle with limited space, so city planners should consider setting aside areas for farming.

Funding: This research did not receive any external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

Abegaz, W. B., & Antensay, M. (2020). Rainfall variability and trends over central Ethiopia. *International Journal of Environmental Sciences & Natural Resources, 24*(4), 132–144. https://doi.org/10.19080/IJESNR.2020.24.556144

Adeaga, O., Lawal, O., Adedeji, O., & Akinbaloye, O. (2022). Assessment of vegetation cover dynamics in the agro-ecological zones of Nigeria. Bulletin of Geography. *Physical Geography Series, (22)*, 19–32. https://doi.org/10.12775/bgeo-2022-0002

Ayoade, J. O. (2019). Introduction to climatology for the tropics (2nd ed.). *Ibadan University Press.*

Zitta, W. S., & Madaki, D. H. (2020). Climate change, rainfall trends and variability in Jos Plateau. *Journal of Applied Sciences, 20*(2), 76–82. https://doi.org/10.3923/jas.2020.76.82

Chenarides, L., Grebitus, C., Lusk, J. L., & Printezis, I. (2021). Who practices urban agriculture? An empirical analysis of participation before and during the COVID-19 pandemic. *Agribusiness, 37*(1), 142–159. https://doi.org/10.1002/agr.21675

Chinago, A. B. (2020). Analysis of rainfall trend, fluctuation and pattern over Port Harcourt, Niger Delta coastal environment of Nigeria. *Biodiversity International Journal, 4*(1), 1–8.

Clinton, A., & Chinago, A. B. (2021). Drought occurrence in northern Nigeria: Its effects on the developmental efforts of the sub-region. *Cross Current International Journal of Peer Reviewed Journal Human and Social Sciences, 7*(8), 155–158. DOI: 10.36344/ccijhss.2021.v07i08.003

Edokpa, D. O., Ede, P. N., Diagi, B. E., & Ajiere, S. I. (2023). Rainfall and temperature variations in a dry tropical environment of Nigeria. *Journal of Atmospheric Science Research, 6*(02).

Akintunde, J. A., Adzandeh, E. A., & Fabiyi, O. O. (2016). Spatio-temporal pattern of urban growth in Jos Metropolis, Nigeria. *Remote Sensing Applications: Society and Environment, 4*, 44–54. https://doi.org/10.1016/j.rsase.2016.04.003

Nyong, A. O., Udoh, C. A., & Oladipo, E. O. (2008). Climate change and regional weather patterns in Plateau State, Nigeria. *Climate Research Journal, 14*(3), 77–92.

Sufiyan, I., Magaji, J. I., Ogah, A. T., Mohammed, K. D., & Geidam, K. (2020). Effect of climatic variables on agricultural productivity and distribution in Plateau State, Nigeria. *Environment & Ecosystem Science, 4*(1), 5–9.

Ogundari, K., Ademuwagun, A. A., & Appah, O. (2021). A note on rainfall variability and trends in Nigeria: Implications for agricultural production. *Studies in Microeconomics, 11*(2), 184–194. https://doi.org/10.1177/23210222211051

Olayide, O. E., Alabi, T. R., Oyedepo, J. A., & Okechukwu, R. (2024). Assessing rainfall and extreme weather variability for climate-resilient agricultural production systems in Nigeria. *Research Square Preprint*. https://doi.org/10.21203/rs.3.rs-3808332/v1

Shanono, N. J., Nasidi, N. M., & Usman, N. Y. (2022). Appraising the current state of irrigation schemes in northern Nigeria using sustainability pillars. *Environmental Research and Technology, 5*(4), 305–314. https://doi.org/10.35208/ert.1097795

United States Department of Agriculture. (2020). *Alternative Farming Systems Information Center (AFSIC).* National Agricultural Library. https://www.nal.usda.gov/programs/afsic

World Health Organization. (2018). *Increasing fruit and vegetable consumption to reduce the risk of noncommunicable diseases.* https://www.who.int/tools/elena/interventions/fruit-vegetables-ncds

Wuyep, S. Z., Rampedi, I. T., & Ifegbesan, A. P. (2021). *The role of urban vegetable production in Jos (Nigeria) as a source of livelihood. African Journal of Food, Agriculture, Nutrition and Development, 21*(8), 18533–18551. https://doi.org/10.18697/ajfand.103.20300

Zitta, W. S., & Madaki, D. H. (2020). *Climate change, rainfall trends and variability in Jos Plateau. Journal of Applied Sciences, 20*(2), 76–82. https://doi.org/10.3923/jas.2020.76.82